State of Illinois
Illinois Department of Natural Resources

REPORT FOR THE

Urban Flooding Awareness Act

JUNE 2015

Report for the Urban Flooding Awareness Act

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The executive steering committee included the Metropolitan Water Reclamation District of Greater Chicago, DuPage County Stormwater Management, the Madison County Stormwater Program, the City of Decatur, Federal Emergency Management Agency, Illinois Emergency Management Agency, Illinois Environmental Protection Agency, and Illinois Department of Natural Resources. Funding for the report provided by the State of Illinois and through the Federal Emergency Management Agency's Community Assistance Program – State Support Services Element. A full digital copy of the report is available on the Illinois Department of Natural Resources and Illinois State Water Survey webpages. Cover: Top right photo used with permission from The Center for Neighborhood Technology other photos by Illinois Department of Natural Resources

June 2015

Urban Flooding Awareness Act

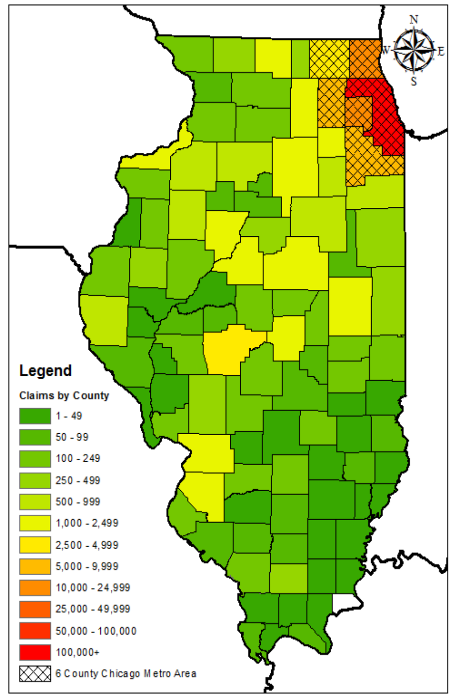
The Illinois General Assembly under the *Urban Flooding Awareness Act* (effective August 3, 2014) tasked the Illinois Department of Natural Resources (**IDNR**) to prepare a report on the extent, cost, prevalence, and policies related to urban flooding in Illinois and to identify resources and technology that may lead to mitigation of the impact of urban flooding. IDNR has prepared this report in collaboration with the Illinois Emergency Management Agency (**IEMA**), the Illinois Environmental Protection Agency (**IEPA**), the Illinois Housing Development Authority (**IHDA**), the Illinois Department of Commerce and Economic Opportunity (**DCEO**), the Illinois Department of Insurance (**IDOI**), the Federal Emergency Management Agency (**FEMA**), the Metropolitan Water Reclamation District of Greater Chicago, (**MWRDGC**), the Illinois State Water Survey (**ISWS**), and other concerned agencies.

The *Urban Flooding Awareness Act* specifically identifies nine topics to be addressed in the report as follows:

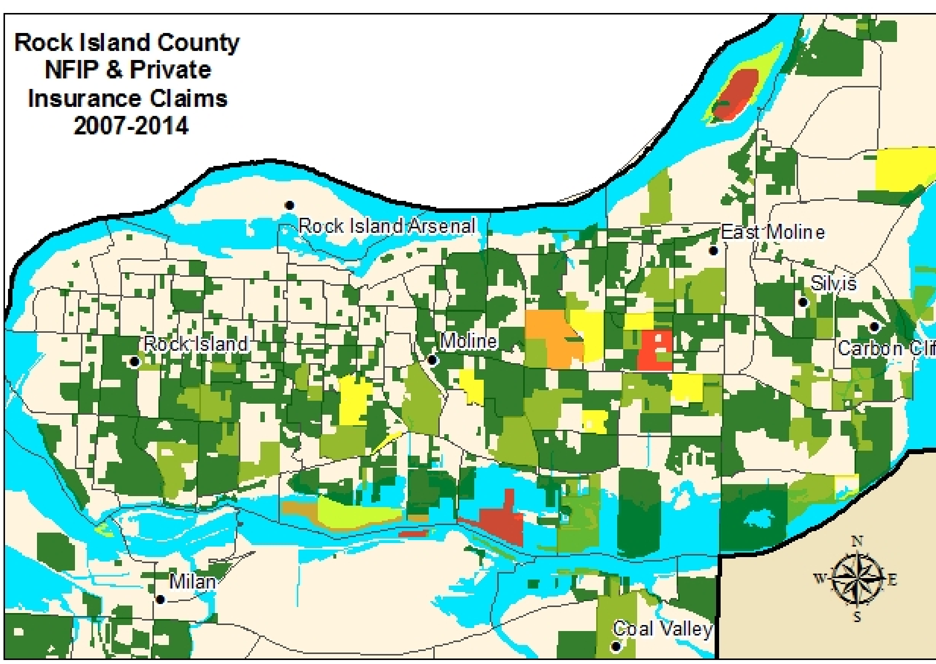
1. Prevalence and costs associated with urban flooding events across the state, and the trends in frequency and severity over the past two decades
2. Apparent impact of global climate change on urban flooding
3. The impact of county stormwater programs on urban flooding over the past two decades, including a list of projects and programs and the flood damages avoided
4. An evaluation of policies such as using the 100-year storm as the standard for designing urban stormwater detention infrastructure and the 10-year storm for the design of stormwater conveyance systems
5. Review of technology to evaluate the risk of property damage from urban flooding and whether a property is in or adjacent to a 1% (100-year) floodplain or not, including LiDAR and GIS
6. Strategies for minimizing damage to property from urban flooding, with a focus on rapid, low-cost approaches such as non-structural and natural infrastructure, and methods for financing them
7. The consistency of the criteria for state funding of flood control projects between IDNR, IEMA, and DCEO
8. Strategies for increasing participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS)
9. Strategies and practices to increase the availability, affordability and effectiveness of flood insurance and basement back-up insurance

Executive Summary

The Illinois General Assembly under the *Urban Flooding Awareness Act* (effective August 3, 2014) tasked the Illinois Department of Natural Resources (IDNR) to prepare a report on the extent, cost, prevalence, and policies related to urban flooding in Illinois and to identify resources and technology that may lead to mitigation of the impact of urban flooding. IDNR has prepared this report in collaboration with the other state agencies identified in the Act. The *Urban Flooding Awareness Act* specifically identifies nine topics to be addressed in the report. These topics fall under three themes: Past, Current and Future flooding; Effectiveness of Projects, Programs and Policies; and Strategies for Reducing Urban Flood Damages. Each of the topics is explored in the main body of the report, with more detailed analyses provided in the appendices.



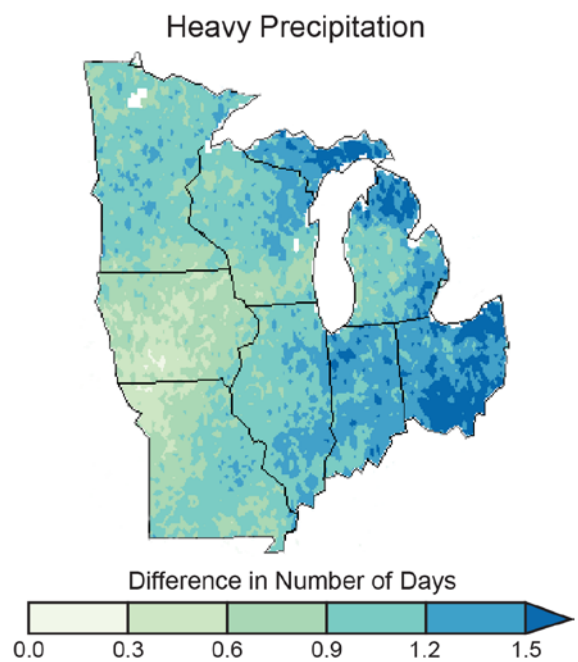
Flooding in urban areas has received increasing attention in the last decade, with at least $2.319 billion in documented damages between 2007 and 2014, of which $1,240 billion were private claims that typically represent basement flooding and sewer backup. Although the largest percentage of insurance claims is from northeastern Illinois, urban flood damages and problems occur statewide in urban areas. Urban flooding as defined by the Act is "The inundation of property in a built environment, particularly in more densely populated areas, caused by rainfall overwhelming the capacity of drainage systems, such as storm sewers. 'Urban flooding' does not include flooding in undeveloped or agricultural areas." **Over 90% of urban flooding damage claims from 2007 to 2014 were outside the mapped floodplain,** which is roughly proportional to the developed floodplains within Illinois urban areas.



Between 2007 and 2014 there have been a total of 1972 urban flood damage claims within Rock Island County. Roughly three-fourths (71.3%) of the claims occurred outside the mapped floodplain.

There are numerous contributing factors to urban flooding, and in any location the causes may be unique. Urban flooding is most common in older sections of communities where original storm sewers were not designed to present-day standards; urbanization has increased runoff, and climate is trending to more frequent and intense storm events. In counties which have been granted countywide authority to establish funded stormwater management programs, progress is being made to reduce urban flooding, but much remains to be done. Most counties do not have authority to establish programs to manage the effects of urbanization. **Communities may have the authority to impose design standards and ordinances but often do not have the legal authority to establish a dedicated funding stream,** making it difficult to maintain and improve storm sewer systems when these repair projects must compete for general funding support.

Urban flooding is expected to increase unless action is taken. There are a number of factors contributing to increased precipitation and more heavy rain events in recent decades, and several lines of evidence suggest that the current patterns will continue in the future. Technology provides numerous tools to analyze data and develop strategies to deal with existing and future urban flooding. However, current basic data collection and analyses are inadequate, and efforts should be extended to ensure Illinois is collecting information needed to guide programs and policies to reduce flood damages. There are many options to mitigate urban flood damages, such as green and gray infrastructure, and increasing open areas in areas of redevelopment. **Storm sewer infrastructure is the underpinning of urban drainage, and action is needed to update aging, undersized systems.**



Possible increases in the heaviest 2-percent storms from the 1971-2000 base period to the period 2041-2070 based on the A2 high emission scenario. Source NCA (2014).

Changes to infrastructure and the urban landscape will take years; however, communities and individuals can take action now to reduce risk and damages. Programs such as the Community Rating System provide guidance for higher standards and community actions to reduce risk. Individuals can purchase sewer and basement insurance as riders to homeowners insurance and flood insurance through the National Flood Insurance Program. Education and training for communities, insurance agents and property owners is critical to understanding risks and how to mitigate and correctly insure those at risk. Sustained outreach is needed for better informed stakeholders.

The state can provide leadership for communities. The state can develop tools, provide technical assistance and raise awareness. The state can incentivize communities through a variety of mechanisms including access to grants and revolving funds for communities that take responsibility for addressing flooding issues. Most importantly, the state can assist communities by aligning the authorities for justification of state capital projects. These are currently inconsistent, making it more difficult to seek funding from one state agency versus another for similar flood damage reduction purposes.

The responsibility for urban flooding lies at all levels, from state government to individual property owners, and a tiered approach is required for all aspects of stormwater management. The research presented in this report has led to 33 recommendations that have been grouped by four levels of responsibility **(see Urban Flooding Awareness Act Report Recommendations, page 78)**, some of which require legislative action, executive authority, state agency engagement, community action, and action by an informed public.

As recommended in this report, the Illinois Department of Natural Resources is already working with other key state agencies to: develop a draft state model stormwater ordinance for local communities, determine how best to appropriate expenditures of state revolving funds for stormwater management measures; and coordinate federal and state mitigation grant programs and projects potentially addressing urban flood measures through the Illinois Mitigation Advisory Group. **The remaining recommendations in the report address the need for authorities, education and awareness, local regulations, collaboration between government agencies and communities, and funding for programs and data collection efforts to reduce future flood damage costs in the State of Illinois.**

Harlem & Irving Park, April 2013, (WGNTV)

Lake Zurich basement, June 2013 (Chicago Tribune, Dan Waters)

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Introduction

The State of Illinois has a long history of losses due to flooding. All of the 102 counties have experienced flooding sufficiently severe to warrant a Presidential Disaster Declaration. When the average citizen suffers property damages, transportation disruption or employment interruption because of excess water, regardless of the source or cause, they have experienced flooding. News reports and public comments about flooding often do not identify the source of the excess water causing the damage. However, in the myriad of government programs and regulations, there are very specific definitions of "flooding" as it pertains to a particular program. This report examines urban flooding as defined by the *Urban Flooding Awareness Act*. The intent is to better understand the characteristics of urban flooding and the factors contributing to urban flooding: where it occurs, why it occurs, how it is currently managed, how it could be managed, where responsibilities lie for management as well as looking to the implications of changes in the future climate.

Available information and data related to urban flooding have been collected statewide to address the topics identified in the Act. The common factors contributing to urban flooding were identified to develop a common understanding of the focus of the investigation. A working definition of "urban" was used to develop geographic distribution. A systematic review of data was conducted to determine the prevalence and costs associated with urban flooding, past to future. Current programs at the community, county, state and federal level were reviewed to explore the effectiveness of projects, programs and policies. Strategies and recommendations for minimizing the impacts of urban flooding were explored and evaluated.

The report begins with a working definition of urban flooding, an examination of the factors contributing to urban flooding and the geography and demographics of urban areas in Illinois. Each of the issues identified in the Act are organized under three themes: Past, Current and Future; Effectiveness of Projects, Programs and Policies; and Strategies for Reducing Urban Flood Damages. Each section provides a brief description of the issues, data, observations and recommendations where appropriate. Recommendations are summarized at the end of the report (see Urban Flooding Awareness Act Report Recommendations, page 78). Detailed analyses supporting and/or enhancing the information included in each chapter of the report are provided in the appendices.

Urban Flooding

Urban flooding as defined in PA98-0858, the *Urban Flooding Awareness Act*

"The inundation of property in a built environment, particularly in more densely populated areas, caused by rainfall overwhelming the capacity of drainage systems, such as storm sewers. 'Urban flooding' does not include flooding in undeveloped or agricultural areas. 'Urban flooding' includes (i) situations in which stormwater enters buildings through windows, doors, or other openings, (ii) water backup through sewer pipes, showers, toilets, sinks, and floor drains, (iii) seepage through walls and floors, and (iv) the accumulation of water on property or public rights-of-way."

Characteristics

Urban flooding is characterized by its repetitive, costly and systemic impacts on communities, regardless of whether or not these communities are located within formally designated floodplains or near any body of water. These impacts include damage to buildings and infrastructure, economic disruption, and negative effects on health and safety.

Common Factors

In an urban environment, these common factors can independently or in combination lead to urban flooding and urban flood damage.

- **Environmental factors**
  - A flat or gently sloping landscape inhibits immediate flow of precipitation away from sites and increases the potential for flooding issues.
  - Precipitation that cannot be absorbed by saturated or poorly drained soils or that occurs in areas with high groundwater can accumulate in low-lying areas and enter buildings.
  - Increasing frequency and intensity of weather events are placing more pressure on urban drainage systems.
- **Development and impervious surfaces**
  - In an urban setting, overland water paths may not be provided or can be obstructed by development, causing localized flooding.
  - As more land is converted to urban and suburban areas, the amount of undeveloped land available for water infiltration into the soils decreases.
  - The natural process of overbank flooding from rivers, streams, and lakes can be exacerbated by development, leading to frequent and chronic flooding.
- **Aging and limited infrastructure**
  - *Combined sewer capacity exceeded*: Older areas of communities may have combined sanitary and storm sewers, which can be overwhelmed during precipitation events.
  - *Storm sewer capacity is exceeded*: Storm sewers are designed to convey specified precipitation events that, if exceeded, will result in water ponding in streets, yards and right-of-ways, adversely affecting quality of life, property values, and public safety.
  - *Storm sewers that cannot drain due to flooded open channel receptors*: During major precipitation events impacting a larger geographic area, receiving rivers and streams may rise to a depth that prevents the discharge from storm sewer outlets, even to the extent of backflow through the sewer system.

Urban Areas

Urban areas are defined by the U.S. Department of Commerce, U.S. Census Bureau (USCB) as densely developed residential, commercial and other nonresidential areas. For the purpose of data analyses, census block data were used to identify the geographic locations of urban areas. The USCB definitions were used as a basis but broadened to encompass high-density population areas where urban flooding may occur. See Appendix A for a detailed description of urban area census analyses.

In total, 291,988 census blocks are designated as urban in Illinois for the purposes of urban flooding, including at least a substantial part of 1,193 municipalities. See Appendix A for a complete list of urban municipalities. Total urban land area in Illinois shown in Figure 1 is 4,170 square miles out of 56,350 square miles (7.4 %). Fifty-two percent (52%) of Illinois urban area is located in the six-county Chicago Metropolitan Area of Cook, DuPage, Lake, McHenry, Kane, and Will Counties, and 7.8% of urban area is located in the St. Louis Metro East area (Madison, St. Clair, and Monroe Counties). The remaining 37.2% of urban area is located throughout Illinois, a significant portion of which includes Bloomington-Normal, Champaign-Urbana, Danville, Decatur, Peoria, Rockford, Springfield, the Quad Cities, Carbondale, and numerous county seats.

Census Block Data

In urban areas, a census block can be as small as one city block but is much larger in rural areas. Census blocks can range in population from zero to several hundred. Blocks are typically bounded by streets, roads or creeks.

Urban Demographics

A total of 12.8 million people live in Illinois, of which 11.7 million (90.5%) live in urban areas as delineated in Figure 1. Approximately 70% of the urban population lives in the six-county Chicago Metropolitan Area (Cook, DuPage, Kane, Lake, McHenry, and Will Counties), 4% live in the St. Louis Metro East area (Madison, Monroe, and St. Clair Counties), and the remaining 26% are located in the remaining Illinois urban areas (Figure 2). Cook County accounts for 5.1 million (63%) of the 8.2 million living in the Chicago Metro area, or over 44% of all urban dwellers in Illinois. The median household income in 2013 in urban Illinois was $55,439, compared to the median of $57,196 for all of Illinois (Figure 3). See Appendix A for additional demographic details.

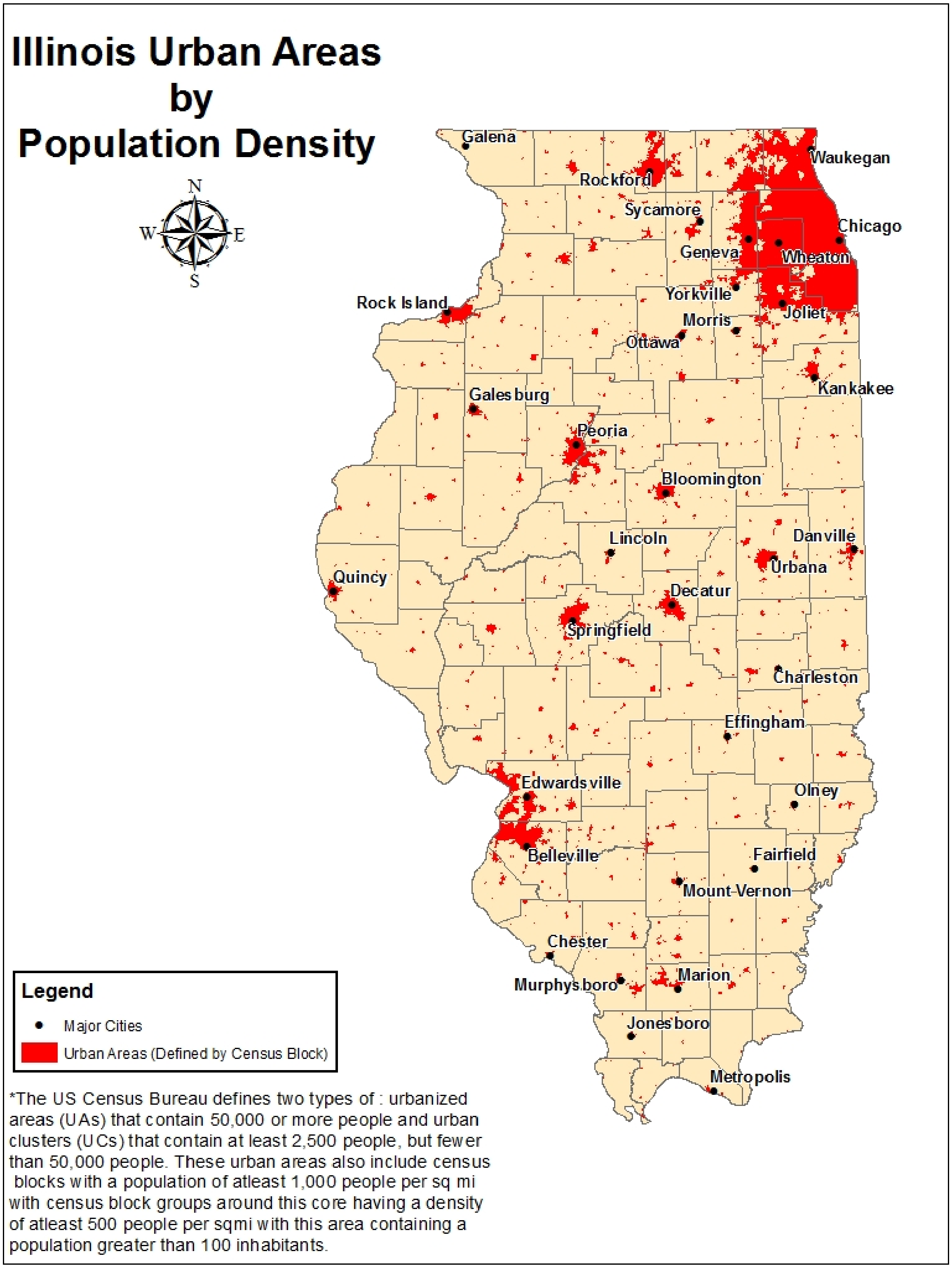


Figure 1: As of 2014, urban areas in Illinois account for 7.4% of total land area of the state. Land use within areas now identified as urban has changed from forest, agriculture, and wetlands to developed urban uses, which now cover about 80% more land area.

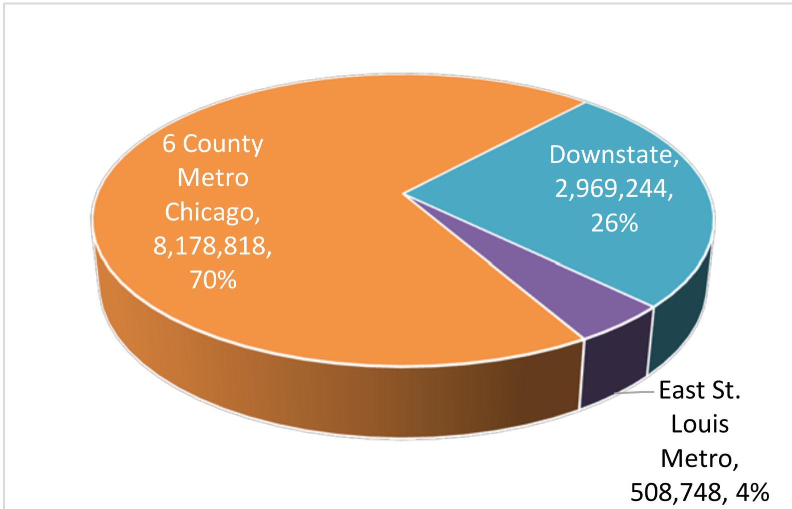


Figure 2: Illinois urban population by region

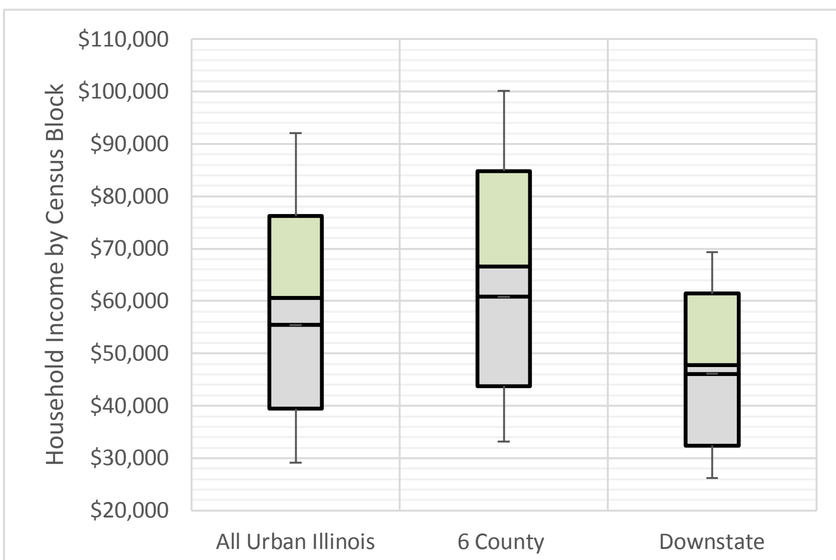


Figure 3: Household income in Illinois urban areas. Median household income in 2013 in urban Illinois was $55,439, compared to $57,196, the median of all Illinois. The median household income of the six-county area is $60,833 and $54,094 for Cook County alone. The remainder of Illinois had a median household income of $46,107.

Stakeholder Engagement and Data Gathering

Urban Flooding Survey

A survey was drafted by IDNR and hosted on the online site, Survey Monkey. Links to the survey were distributed in October 2014, which remained open until November 12, 2014. The survey was designed to collect uniform urban flooding data from communities including: amount, type, cause, management methods, project funding, and general design criteria. Invitations to the voluntary, online survey were sent to more than 300 individuals (16 federal representatives, 134 county representatives, 64 city representatives, and 107 other stakeholders), and 123 responses were received. Survey respondents represent 120 municipalities, townships, counties or other entities located within 21 Illinois counties. The survey findings are detailed in Appendix B.

Stakeholder Meetings

Three sets of meetings were held at different stages during the report writing process: information gathering, data analysis, and recommendation formulation. One meeting for each stage was held in the Springfield and northeastern Illinois areas and were attended by federal and state government partners, county agencies and engineers, municipalities, and other engineers, associations, and groups interested in flood management. The minutes and attendee lists from these meetings can be found in Appendix B.

In addition, an executive committee was formed to provide input during monthly conference call meetings held to discuss report content and progress. Members of the executive committee were chosen from a wide range of groups, which included the Metropolitan Water Reclamation District of Greater Chicago, DuPage County Stormwater Management, the Madison County Stormwater Program, the City of Decatur, FEMA, IEMA, IEPA, and IDNR.

Data Gathering

Information was requested and gathered from many different sources during the data collection phase of the report through numerous meetings and contacts (see Appendix B). Insurance information was gathered from IDOI and FEMA. Stormwater ordinance information was collected from communities and counties. Reports were requested from counties with stormwater authority to determine the benefits of those authorities. Information about combined sewer locations was supplied by the IEPA.

Illinois Flood Risk Symposium

The Illinois Association for Floodplain and Stormwater Management (IAFSM) in partnership with the Association of State Floodplain Managers (ASFPM) Foundation held a Flood Risk Symposium on February 10, 2015. IAFSM hosted the symposium to facilitate discussion of urban flooding as highlighted by the *Urban Flooding Awareness Act*. The 80 symposium attendees included a diverse representation of professionals that included local floodplain managers from Chicago and downstate Illinois, state and federal officials, urban planners, insurance and real estate representatives, hydrologists, hydraulic engineers and experts in key topics. The symposium was held to identify: urban flood risk, urban flood risk reduction methods, and sources of funding. The IAFSM Illinois Flood Risk Symposium report, provided in Appendix C, presents an overview of the discussions, captures the consensus of these professionals, and identifies recommended actions toward addressing urban flooding issues.

Section 1
Past, Current, and Future

This section examines the cost and prevalence of urban flooding, tools for identifying potential urban flooding areas, and the outlook for climate change impacts. The prevalence and cost of urban flooding is explored by examining past flood events and available information on cost. Understanding that there are multiple contributing factors, available tools and data that could indicate areas potentially at risk of urban flooding are reviewed. Current knowledge of climate trends and their implications are discussed.

Source: Center for Neighborhood Technology

Source: Center for Neighborhood Technology

Chapter 1: Prevalence and Cost

The cost of flooding spreads through many sectors, with direct damages to structures, damages to infrastructure, economic losses from business interruption, interruption of service, and more. This chapter focuses on damages experienced by individuals and communities using data available on insurance payouts and disaster relief. Data on economic losses due to interruption of services or productivity are not available. The data presented serve as an indicator of the geographic distribution and magnitude of the costs associated with flooding in urban areas.

Key Findings

- Flooding in urban areas has resulted in at least $2.319 billion in documented damage since 2007. 85.2% of all payouts (2007-2014) were located in the six-county Chicago Metropolitan Area of Cook, DuPage, Kane, Lake, McHenry, and Will Counties (Figure 1.1).

- The top five damaging storm events in Illinois occurring between 2007 and 2014 totaled $1.6 billion and 69% of all payments.

- The limited time frame (2007-2014) of data for private insurance claims and disaster assistance claims makes determining the presence (or lack) of a trend difficult. However, on the basis of the National Flood Insurance Program (NFIP) claims data that span a much longer time period (1979-2014), the following trends were observed:
  - NFIP claims and payouts have trended up steeply during the last 15 years, driven by the three largest events.
  - Over 90% of urban flooding damage claims from 2007 to 2014 were outside the mapped floodplain, which is roughly proportional to the developed floodplains within Illinois urban areas. The household income distribution of NFIP claimants is very similar to the household income distribution for all urban areas. The private insurance income distribution is shifted slightly towards higher annual income households. The income distributions of NFIP and private insurance claimants may be affected by the insurance options and individual choices.

- Individual Assistance payments from FEMA constitute a large portion of the costs of urban flooding, but this source of support is only available when there has been a Presidential Disaster Declaration.

- Data limitations are important to note when assessing the findings in this section. The various data available represent different time periods, different degrees of accuracy, and likely represent only a sample of claims and damages that actually occurred. The cost, timing, prevalence, and trends of urban flooding presented are qualitative indicators.

Three cost indicators have been examined (see Appendix D). These are:

- Private insurance claims
- National Flood Insurance Program (NFIP) claims (see Chapter 7 for more information about the NFIP)
- Federal disaster relief

Private claims data represent basement/foundation flooding, including sump pump failure and sewage backup not due to riverine flooding.

The NFIP claims data represent flooding due to overland flow (primarily riverine), which may or may not coincide with urban flooding as defined for this report.

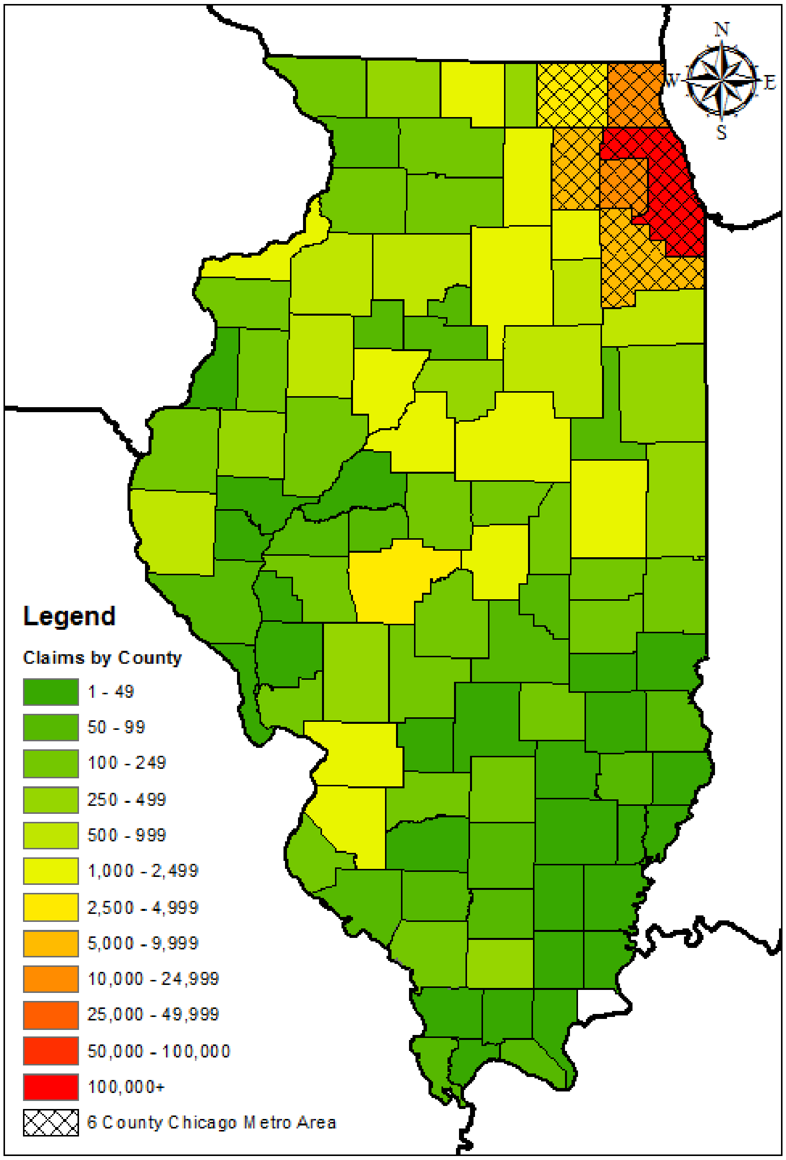


Figure 1.1: Urban Flooding Claims by County. Between 2007 and 2014, 175,775 out of 184,716 (95.16%) of private insurance claims and 12,950 out of 14,693 (88.13%) of NFIP claims were located in urban areas. A total of 94.63% of all claims were located within urban areas and were located in 101 out of 102 counties.

Federal Disaster Relief claims relating only to flooding and severe storm events were included in the urban flooding analysis. The Disaster Relief Fund provides Individual Assistance (IA) and Public Assistance (PA) programs. IA provides money and services to people in presidentially declared disaster areas and include both household and personal assistance. These payments are not dependent on property ownership or whether a dwelling is located in a designated floodplain. Small Business Assistance loans are also available but not included in these totals. The PA program offers assistance to state, local, and tribal governments after a declared major disaster or emergency for eligible disaster-related damage.

Urban flooding is not concentrated to small areas but is far-reaching and affects much of the urban landscape. Figure 1.2 displays the Rock Island urban area and the number of NFIP and private claims per census block between 2007 and 2014, within and outside of the mapped floodplain.

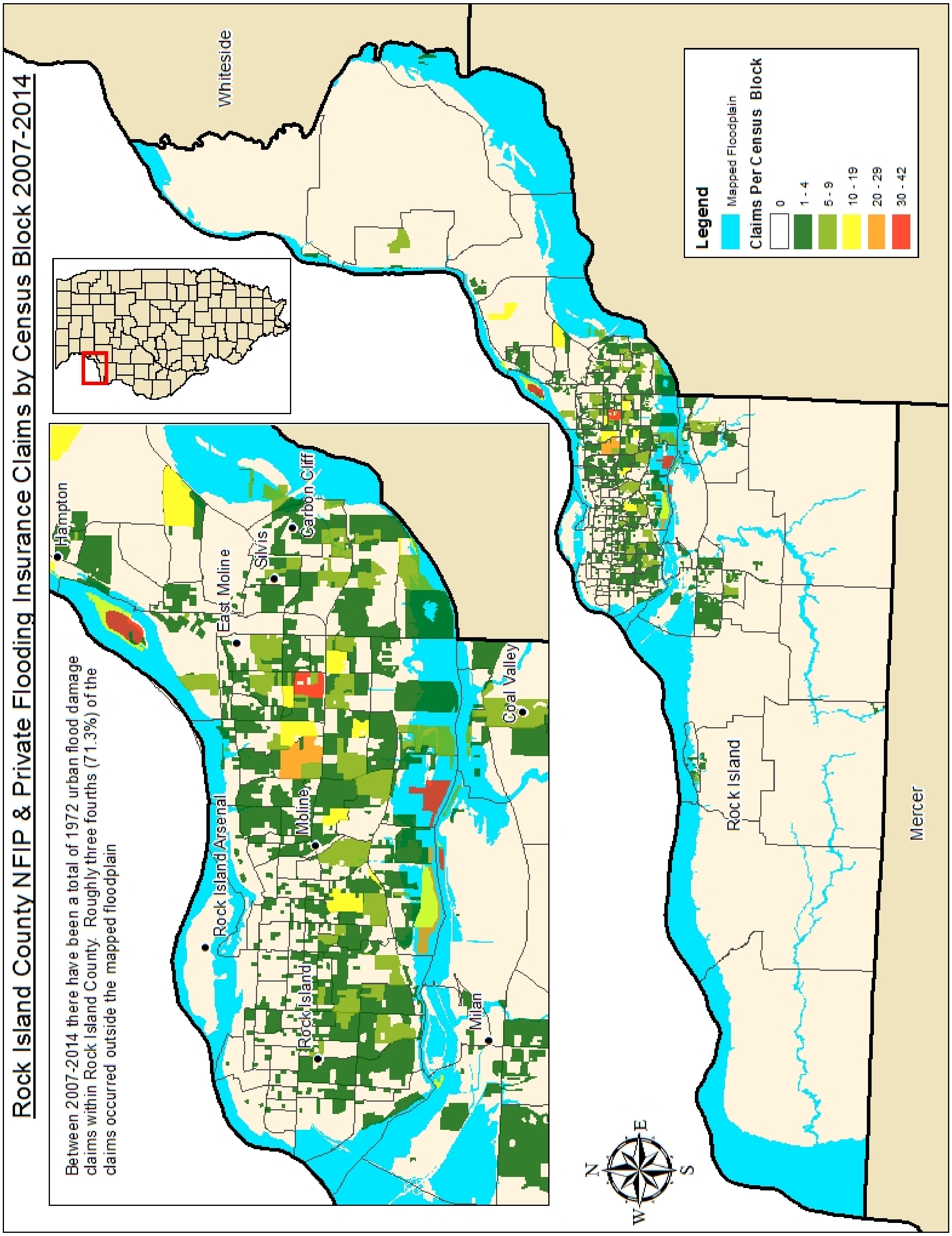


Figure 1.2: Between 2007-2014, there have been a total of 1972 urban flood damage claims within Rock Island County. Roughly three-fourths (71.3%) of the claims occurred outside the mapped floodplain."

Urban Flooding in the Floodplain

To determine the prevalence of urban flooding in relation to riverine floodplains, the NFIP and private claims data were compared with the most current 1% annual chance floodplain (100-year flood) dataset for Illinois. The disaster assistance data could not be used in the analyses as the data are aggregated by zip code and not by census block. Using the national land cover data set (see Chapter 3), urban areas were divided into "developed" and "undeveloped" areas. Undeveloped areas are composed of open water, forest preserve, and other types of open space. Comparing the classifications of the urban area within the floodplain, the approximate urban developed area within the floodplain was determined.

About 11.3 % of urban areas are within the mapped floodplain (471 square miles of mapped floodplain in 4,171 square miles of urban area). About half of the area of mapped floodplain (Special Flood Hazard Area) in urban areas has been developed.

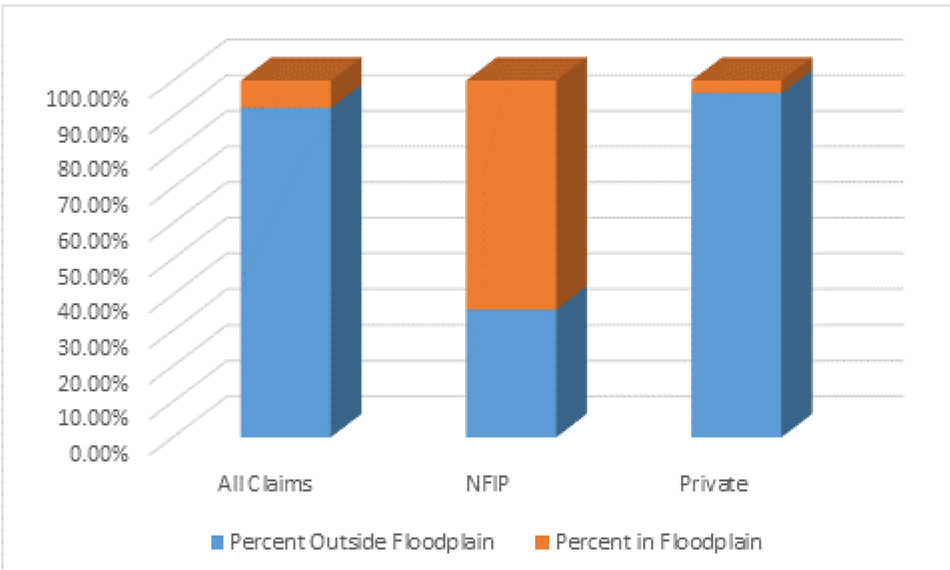


Figure 1.3: Between 2007 and 2014, most (96.5%) of private insurance claims are for structures outside the mapped floodplain; however, a significant number of NFIP claims (35.9%) are outside the mapped floodplain.

Table 1.1: Insurance Claims in and out of the mapped floodplain 2007-2014.

Claims Source	Percent Outside Floodplain	Percent in Floodplain
All Claims	92.3%	7.7%
NFIP	35.9%	64.17%
Private	96.57%	3.57%

Private, NFIP and Federal Disaster Relief claims data have limitations which must be considered when interpreting the data. Private insurance claims reflect the ability and willingness of individuals to pay increased insurance costs for riders to cover sump pump failure or sewer backup and may also be limited by the reluctance of individuals to file claims; NFIP policies are not in place for many structures located both within designated flood hazard areas and those structures located near, but outside the mapped floodplain; and federal disaster assistance becomes available only when certain thresholds are met.

Compilation of these data provides an indication of the cost of urban flooding as indicated in Table 1.2 and Figure 1.4. Private insurance claims data are available for the period 2007 to 2014, NFIP data are available from 1979 to 2014 but were calculated only for the period from 2007-2014, and Disaster Assistance in the form of PA and IA is available from 2007-2014. Statewide data on economic losses due to service interruptions and productivity are not available, but there is a potential for further study either through direct data collection or through modeling.

Table 1.2: Claims Payments 2007-2014

Claims Source	Total Payout ($)	Urban Claims	Urban Claims Paid	% No. Paid
Private	$1,239,984,361	175,775	136,687	77.76%
NFIP	$229,743,519	12,950	10,662	82.33%
IA	$691,868,175	308,540	206,126	66.81%
PA	$157,568,563	-	-	-
Total	$2,319,164,168	497,265	353,603	71.08%

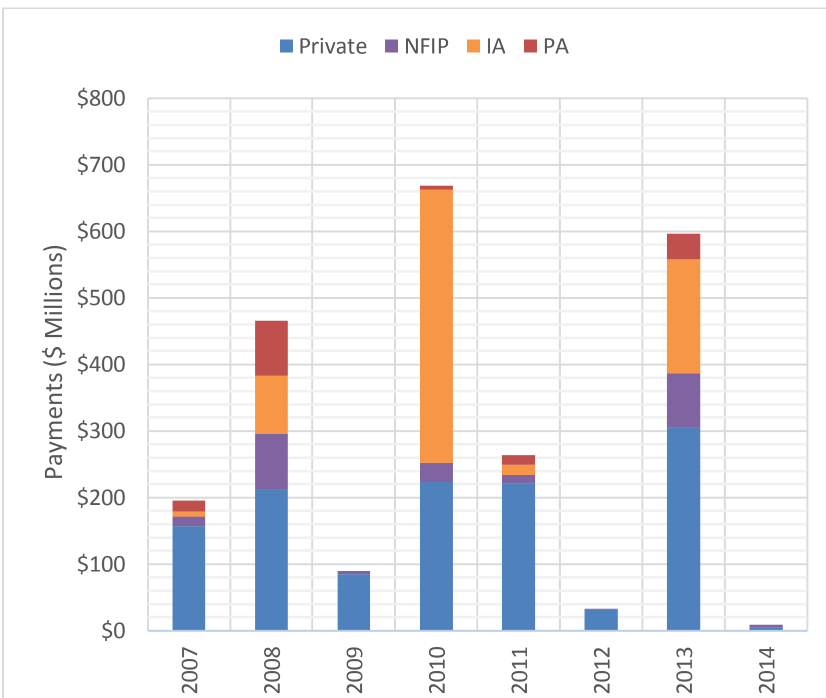


Figure 1.4: Total flooding insurance payouts per year, partitioned by claim type. Private insurance covers the majority of urban flooding claims on average; however, disaster relief assistance payouts can be significant in some years. Private claims current through September 2014 and NFIP current through October 2014.

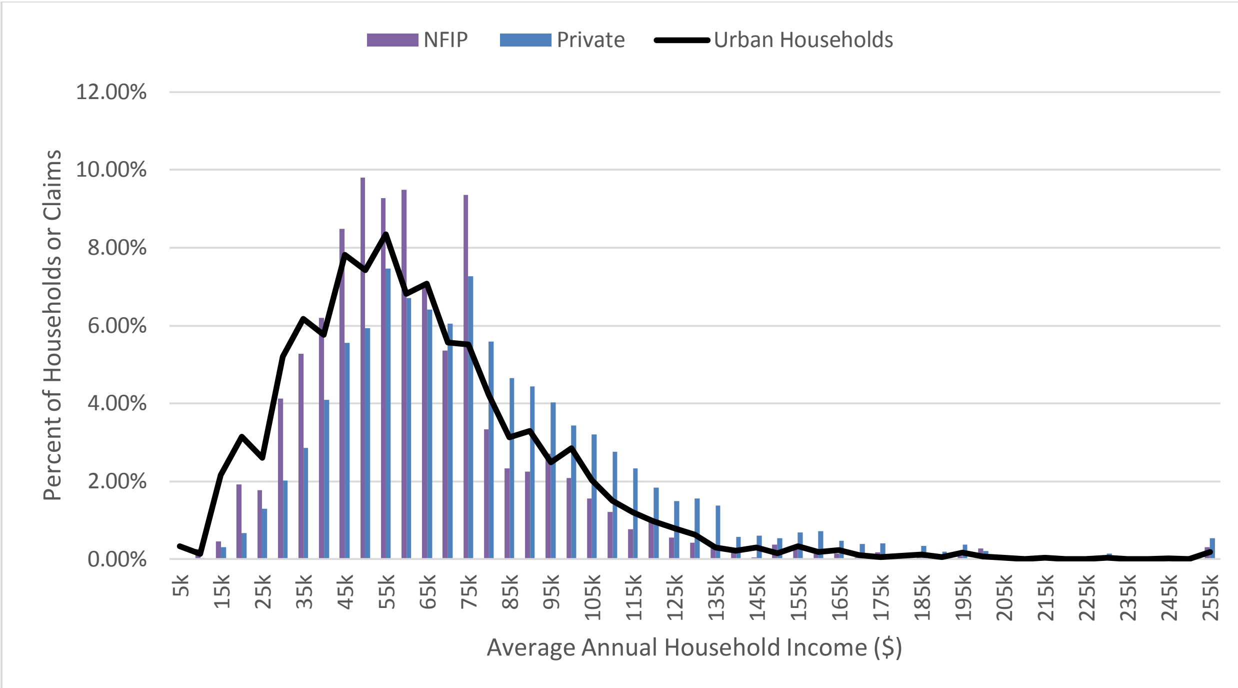


Figure 1.5: Distribution of annual household income for Illinois urban areas and the distributions of annual household income for the NFIP and private insurance claims. The NFIP distribution is very similar to the distribution for the urban area income. The private insurance distribution is shifted slightly towards higher annual income households.

Even though the NFIP claims do not represent the definition of urban flooding, this is the only claims data with a decades-long record, which assists in examining trends in flooding claims. Figure 1.6 shows the increase in NFIP claims payments in Illinois over the decades. Average annual NFIP urban payouts ranged from $6.1 million to $8.7 million during the 1970s, 1980s, and 1990s. During the 2000s, the average annual payout jumped to $12.5 million, and during the first five years (2010-2014) of the 2010s, the average annual payout increased to $25.5 million.

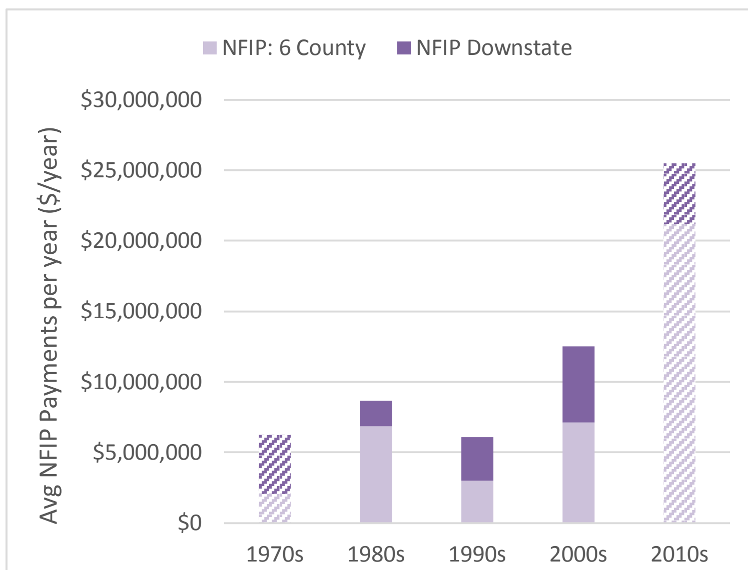


Figure 1.6: NFIP claims and payouts have trended up steeply during the last 15 years primarily due to three large storm events. It is too early to determine if the first half of the 2010s is the beginning of a trend, but this analysis can be readdressed in five years. Hatching denotes decades with partial data (1976-1979 and 2010-2014).

The timing, location, and magnitude of a single severe storm event greatly affect the corresponding urban flooding and insurance claims and payouts. The five storm events resulting in the highest total NFIP payouts (1976-2014), the highest total private payouts (2007-2014), and the highest total payouts (2007-2014) are shown in Table 1.3. The top three storm events were the same for both the NFIP and private claims. Four of the top five storm events in terms of total NFIP and private insurance payouts prompted disaster declarations and so IA and PA were also distributed.

Table 1.3: Storm Event Ranks by NFIP, Private, and Total Payments

Rank	NFIP (1976-2014)	Private (2007-2014)	NFIP + Private (2007-2014)
1st	4/17-18/2013	4/17-18/2013	4/17-18/2013
2nd	9/13-14/2008	9/13-14/2008	9/13-14/2008
3rd	7/23-24/2010	7/23-24/2010	7/23-24/2010
4th	7/17-18/1996	7/22-23/2011	7/22-23/2011
5th	8/14/1987	8/23-24/2007	8/23-24/2007

Recommendations

1. The Illinois General Assembly should allow the Illinois Department of Insurance to mandate continuing education specific to flood insurance for insurance agents.
2. Insurance companies only retain claims data for eight years. The General Assembly should fund a program at the Illinois Department of Insurance to archive basement flood damage claims data from private insurers to maintain a long-term census block database of flooding claims for future analysis.
3. The Illinois General Assembly should fund research to determine if lower income households have adequate private basement backup and flood insurance as they appear to have fewer private insurance claims than higher income households. If affordability is an issue with private basement coverage or flood insurance, incentive programs and insurance pools used by other states should be investigated.
4. The Illinois General Assembly should direct research on a state Urban Flood Mitigation Pool funded from a very minimal surcharge on all homeowner's policies in Illinois. This mitigation funding stream could be granted to local governments to identify, study, and mitigate the most egregious urban flood areas in the state.
5. The Illinois Department of Insurance should encourage outreach and education efforts at the local level to ensure that citizens understand the differences between flood insurance and sewer backup coverage.

Chapter 2: Climate Trends and Climate Change

Key Findings

- Illinois precipitation has increased by 10% in the last century. Much of this increase has been from the more intense storms of over an inch. This pattern of more intense storms is expected to continue.
- Although there is significant uncertainty in climate projections, particularly in precipitation and flood projections, increases in the frequency and intensity of extreme precipitation events and urban flooding are projected for all U.S. regions (NCA, 2014).

Precipitation Patterns in Illinois

Illinois receives between 36 and 48 inches of precipitation from north to south on average. Illinois is much wetter than states to the west because of its closer proximity to the Gulf of Mexico, our major source of moisture. About half of the precipitation in Illinois comes from thunderstorms during the warmer months of the year. By their nature, thunderstorms are usually short and intense rainfall events, which can be especially challenging in urban areas. The rest of the precipitation is produced by passing warm and cold fronts and slow-moving low-pressure systems. Some of that precipitation can fall as snow. In this report, precipitation refers to rain events and the water content of snowfall events.

While most daily precipitation amounts are 1 inch or less, the number of days with over 1 inch of precipitation ranges from 7 to 10 days across northern and central Illinois to 10 to 15 days across southern Illinois south of Interstate 70 (Figure 2.1). In fact, up to 40% of the total precipitation in any given year comes from the 10 days with the most rain. In the urban environment, wet months or even wet weeks can increase the risk of flooding from a subsequent storm by saturating the soils, filling retention ponds, and increasing levels of rivers, lakes, and streams. As a result, a 2 to 3 inch storm at the end of a wet week or month may do more damage than the same storm falling during a dry week or month.

Figure 2.1: Average number of days per year with at least an inch of precipitation.

On rare occasions, Illinois has received large amounts of rain from the remains of tropical systems as they move up from the Gulf of Mexico. Examples of this include the remains of Hurricanes Ike and Gustav in 2004 and Hurricane Isaac in 2012. While no longer at hurricane strength, these were capable of producing 3 to 6 inches of rain over very wide areas in 1 to 3 days.

Snowfall is common in Illinois. On average, winter snowfall totals can range from 12 inches in southern Illinois to 36 inches in northern Illinois. Amounts are typically a little higher in the Chicago area due to the additional impact of lake-effect snows. Snowfall can be a contributor to urban flooding if large amounts of it are melted in short order. This can be compounded by melting over still-frozen soils, blocking of storms drains by snow and ice, and rainfall falling on top of the snow pack.

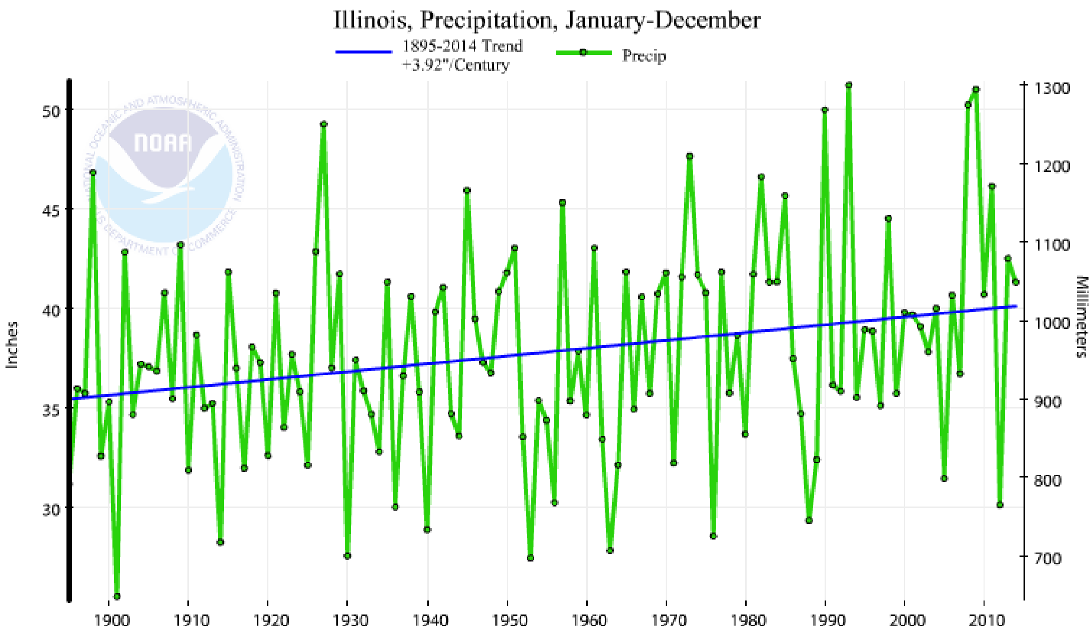


Figure 2.2: Statewide average annual precipitation for Illinois from 1895 to 2014. The green line represents the year to year variation. The blue line is the trend line. Source: National Center for Environmental Information (2015)

Trends in Total Precipitation in Illinois

Historical records since 1895 (Figure 2.2) illustrate the large year- to-year variability in precipitation in Illinois, a trademark of our climate. These data indicate that the statewide average precipitation has increased from 36 to 40 inches or 10% over the last century. Illinois has been more likely to experience exceptionally wet years in recent decades. The year 1993 was the wettest on record with 51.18 inches. The next two wettest years were 2009 with 50.96 inches and 2008 with 50.18 inches. All three years were noted for widespread flooding issues in Illinois.

Trends in Heavy Precipitation Events between Major Illinois Cities

A recent study of changes in heavy precipitation events (Groisman et al., 2012) over the central U.S., including Illinois, found little change in the number of storms between ½ to 1 inches. However, heavy storms (1 to 3 inches), very heavy storms (3 or more inches), and extreme precipitation (more than 6 inches) were becoming more frequent. In fact, the extreme precipitation events increased by as much as 40% during the second half of the study period (1979-2009) compared to the first half of the study period (1948-78).

For this report, daily precipitation records for the last 100 years were examined for several major cities in Illinois. These cities include Chicago, Rockford, Moline, Peoria, Springfield, Bloomington-Normal, Champaign-Urbana, Edwardsville, and Carbondale. Daily precipitation amounts were placed into three categories: 1 to 2 inch storms, 2 to 4 inch storms, and 4 or more inch storms. This slightly different list of categories was chosen to better reflect the kinds of storms found in Illinois. The results are summarized in Figure 2.3 for the entire state. The results for individual cities are provided in Appendix E.

The 1 to 2 inch storm events per city showed modest changes between decades and a small increase over time. The most recent decade, 2005-14, was the highest with an average of 81 events per city.

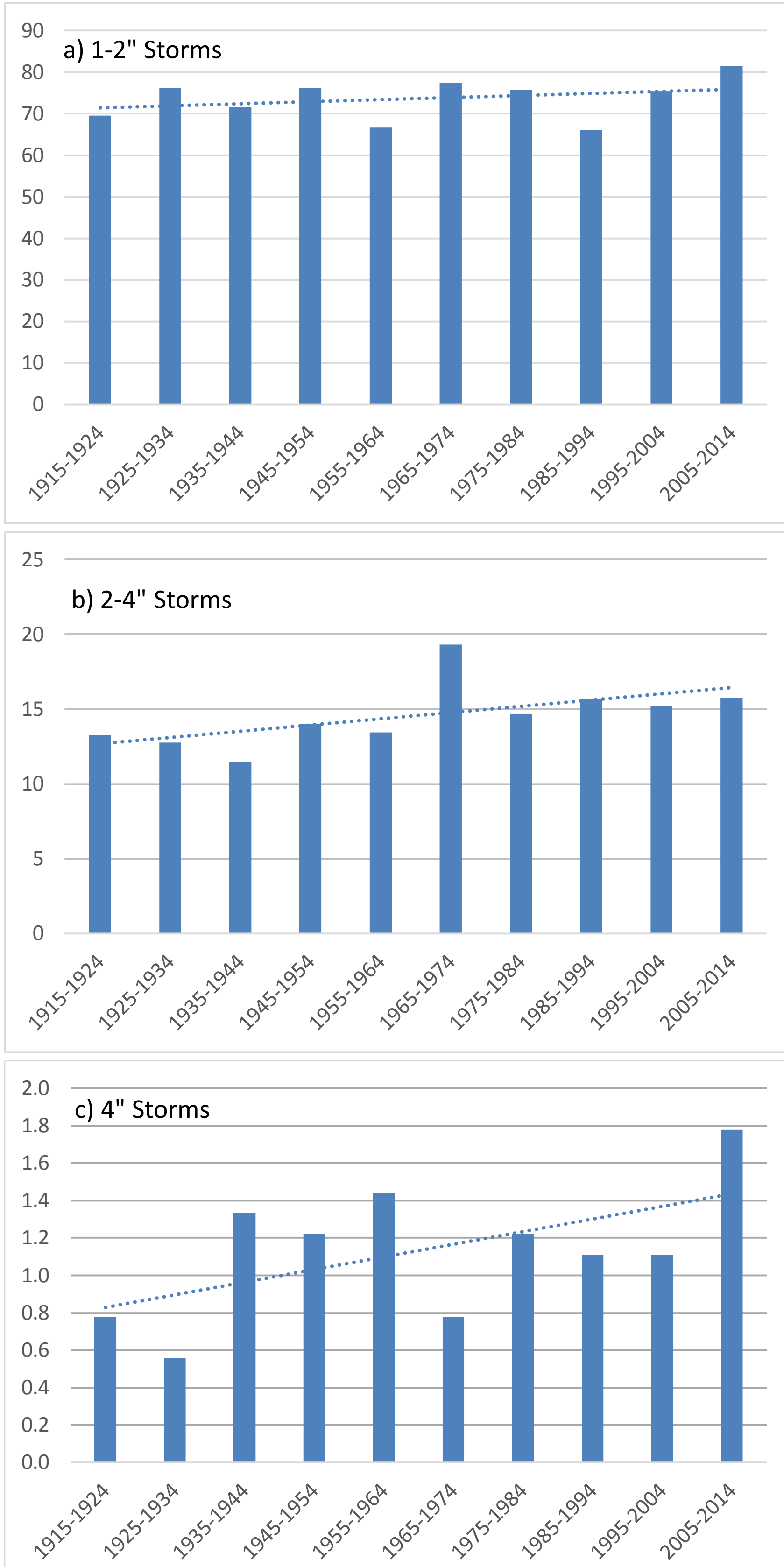


Figure 2.3: Statewide average changes in storm frequency by decade per city for a) 1-2 inch storms, b) 2-4 inch storms, and c) greater than 4 inch storms. The blue dotted line indicates the trend over time.

The statewide average number of 2 to 4 inch storm events per city showed more changes between decades and a moderate increase over time. The lowest decade was 1935-1944 and was likely associated with the number of severe droughts during that period. One of the busiest decades was 1965-1974, when the cities averaged 19 events per decade. The statewide average number of storm events exceeding 4 inches per city has increased steadily over the last century with 2005-2014 the busiest with an average of 1.8 events per city.

Discussion on Precipitation and Heavy Rain Events

There are a number of factors contributing to more precipitation and more heavy rain events in recent decades. First is that temperatures in the U.S. have warmed by about 1.5 to 1.9 degrees (depending on the calculation used) over the last century. Meanwhile, temperatures in Illinois have warmed by about 1.0 degree over the last century. Warmer air has the ability to hold more water vapor. This ability increases by almost 4% with each degree increase. This means that on average storms have slightly more water available for precipitation. It is also possible that the characteristics of storms are changing as the U.S. gets warmer. For example, a longer warm season increased the opportunity for thunderstorms. Additional work in Illinois suggests that the increasingly intense agricultural practices of the Midwest (more acreage and more plants per acre) have elevated summer humidity levels as well (Chagnon, Sandstrom, & Bentley, 2007).

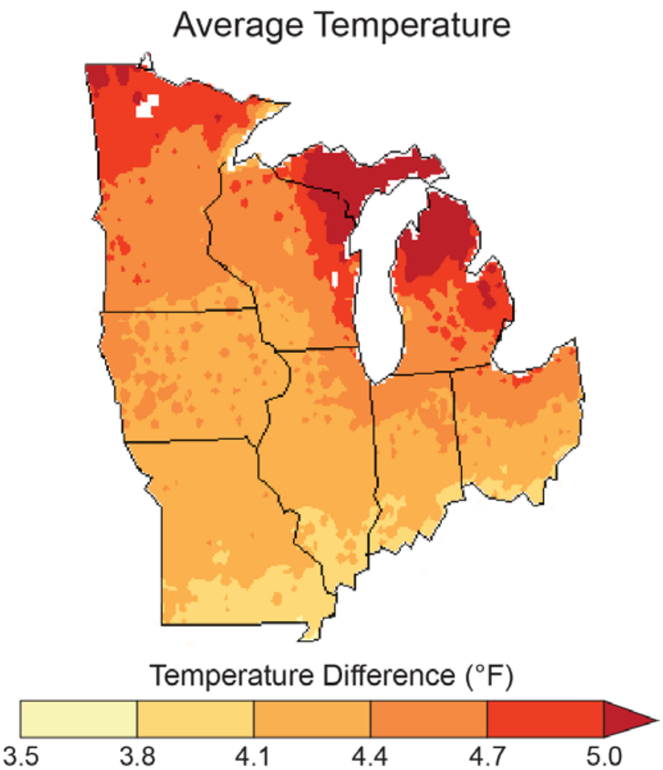


Figure 2.4: Possible increases in the temperature from the 1971-2000 base period to the period 2041-2070 based on the A2 high-emission scenario. Source: NCA (2014).

Another contributing factor is natural variability in precipitation, as is illustrated in analysis of heavy storms in Illinois cities (see Appendix E) – some areas of the state are just stormier than others.

There are several lines of evidence suggesting that the current patterns will continue in the future. The first line of evidence is that past studies in Illinois and elsewhere have suggested that the most recent 5 to 15 years are the best predictor of conditions for the next 1 to 5 years (Easterling, Angel, & Kirsch, 1990). So this suggests that the current wetter and more intense conditions will likely continue in the short term.

The U.S. Global Change Research Program (USGCRP), which was established by presidential Initiative in 1989 and mandated by congress in the Global Change Research Act of 1990 to "assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change," has prepared the National Climate Assessment indicating that temperatures in the U.S. and

Midwest will increase over the next century. The magnitude of this increase is closely tied to the amount of future emissions of heat-trapping gases. One of the higher emission scenarios results in mid-century temperature increases of 3.8 to 4.6 degrees across Illinois (see Figure 2.4). Over the years, a variety of models and scenarios have all resulted in some degree of warming over the next century. As mentioned earlier, warmer air is able to hold more water vapor at the rate of almost 4% per degree increase. This line of evidence suggests that future storms will produce more precipitation and more intense storms as the U.S. and Illinois warms.

The final line of evidence is based directly on the possible future changes in precipitation found in global and regional climate models. It is important to note that model projections of future precipitation patterns are less certain than temperature projections. As noted earlier, while the models have consistently shown warming over the next century, some models indicate that conditions will get wetter while others indicate conditions will get drier across the Midwest. The NCA report based on the most recent research indicates that the Midwest is expected to be wetter by the 2041-2070 timeframe (Figure 2.5). Overall, the Midwest is expected to be wetter in winter and spring and less so in fall while summers could be drier. The NCA report indicates that the Midwest is expected to experience more heavy rain events in the future (Figure 2.6).

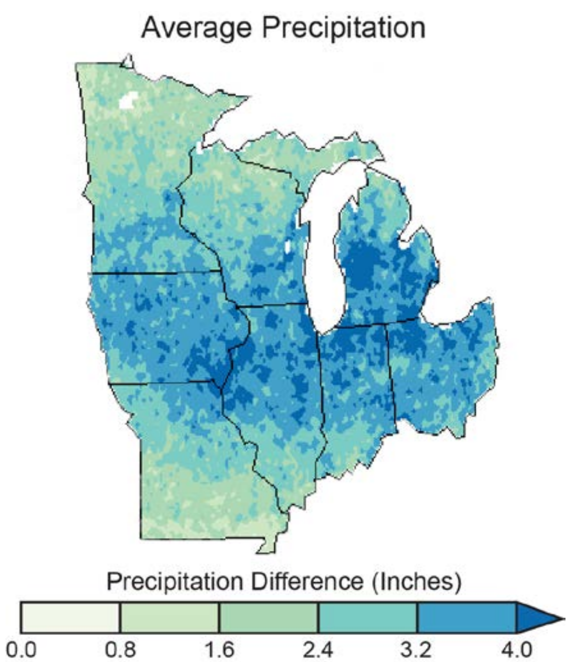


Figure 2.5: Possible increases in precipitation from the 1971-2000 base period to the period 2041-2070 based on the A2 high emission scenario. Source: NCA (2014).

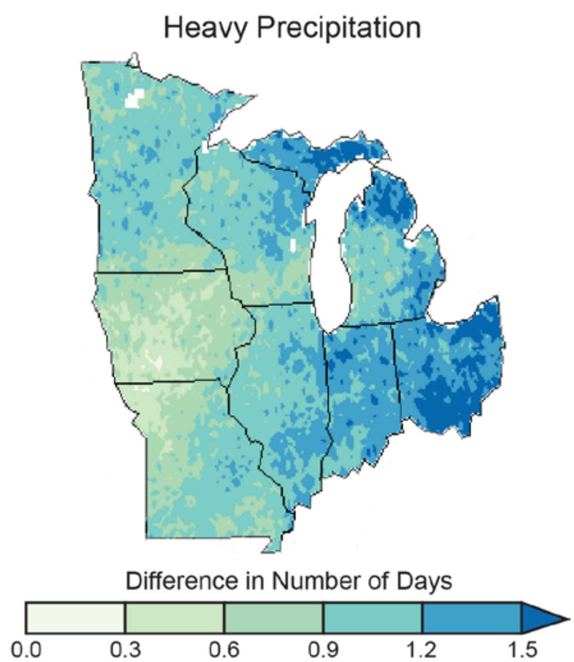


Figure 2.6: Possible increases in the heaviest 2 percent storms from the 1971-2000 base period to the period 2041-2070 based on the A2 high emission scenario. Source: NCA (2014)

Climate Change Considerations

The average Earth surface temperatures increased by 0.83 °C (1.5 °F) from 1880 to the present (IPCC, 2013). Many scientists attribute global warming to human-induced increase in concentrations of greenhouse gasses. According to the U.S. National Climate Assessment (NCA, 2014) "many lines of independent evidence demonstrate that the rapid warming of the past half-century is due primarily to human activities." The NCA Assessment also points to the accumulating evidence of human-induced climate change which further expands our understanding of the observed trends in climate variables.

Traditionally, infrastructure design concepts relied on the assumption that past events can be used to predict future events. Statistical analyses of precipitation and discharge data are used to estimate the magnitude of precipitation or streamflow likely to occur within a time period, such as once in ten years, or once in 100 years on average. No change in the frequency of extremes over time was considered in manuals used by engineers, climate scientists and hydrologists (Perica et al., 2013; USGS, 1982; Soong et al., 2004). However, numerous publications indicate that the frequency of extremes has been changing and is likely to continue changing in the future (Milly et al., 2008; IPCC, 2007). Due to the changing (nonstationary) nature of precipitation and flood extremes, we can no longer rely on analyses of past data to estimate future events. Thus, to estimate the magnitudes and frequencies of future events, it is necessary to account for the nonstationary nature of precipitation and flooding.

Climate models are a primary tool used in climate projections to study the effects of increasing concentrations of greenhouse gasses. Global climate models (GCMs) simulate interactions of the atmosphere, oceans, land surface and ice, and project future climates for various scenarios. Recent analyses (NCA, 2014) indicated that climate models have become more comprehensive and that the earlier predictions have been confirmed. Despite the continuous improvements of these models, the GCM output is averaged over large areas and is not suitable for flood studies. The typical GCM output grid-cell size is approximately 50×70 miles in Illinois. Given that coarse GCMs poorly represent local-scale precipitation, methods have been devised to translate the data to smaller areas. This is called spatial downscaling. There are different techniques that can be applied in spatial downscaling and also to downscale the time increments of the GCM climate data to smaller time increments, making them more usable in flood studies. However, the process and techniques for spatial and temporal downscaling are still evolving.

Decision-making under uncertainty can be particularly challenging. The projected climatic variables, such as temperature and precipitation, are very uncertain. Figure 2.7 shows the projected global temperature change based on two Intergovernmental Panel on Climate Change (IPCC) climate scenarios: A2 which assumes continued increases in emissions throughout this century, and B1, which assumes significant emissions reductions. Because of uncertainties in average temperature and precipitation, the projected changes in their extremes are even more uncertain, making it very difficult to predict future flooding.

Nonetheless, some studies (Mills, 2005) have offered evidence of the direct and significant effects of climate change on increased flooding. Seneviratne et al. (2012) suggest that flood characteristics have changed over time, but the causes and patterns of these changes are complex and regionally

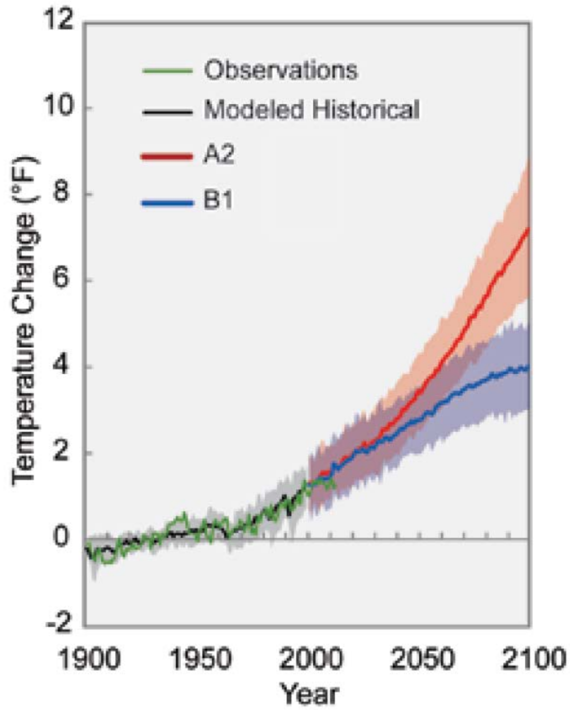


Figure 2.7: Projected global temperature change showing two scenarios: A2 which assumes continued increases in emissions throughout this century, and B1, which assumes significant emissions reductions. Shading indicates the range (5th to 95th percentile) of results (NCA, 2014).

dependent. Thus, these changes should be studied separately for different regions. NCA (2014) states "Increases in the frequency and intensity of extreme precipitation events are projected for all U.S. regions." Furthermore, the same source indicates that the large observed increases of heavy downpours in the Midwest are among the largest in the U.S. As a result of a direct link of urban flooding and heavy precipitation, it is expected that urban flooding will also increase (NCA, 2014), particularly in urban areas in the Midwest.

While projections of flood frequency are uncertain, including data, sampling variability, modeling, and scenario uncertainties, there is an increasing need to incorporate uncertain scientific information of varying confidence levels into flood frequency estimates. Numerous attempts to quantify these sources of uncertainty have been published using multi-model (ensemble) analysis (Christiansen et al., 2010, Smith et al., 2014). These studies can be used not only for determining the expected magnitudes of projected precipitation and floods, but also they offer tools for determining the uncertainty in these projections, typically expressed through the confidence limits around the projected rainfall or flood magnitudes. The confidence limits are of critical importance for making decisions in uncertain environments.

Recommendations

1. The State should fund the Illinois State Water Survey to update the existing rainfall frequency distribution information using the additional rainfall gauge data that are available with routine updates every 15 years. Future precipitation projections and also future land use should be included where it is available. When planning stormwater infrastructure modifications and enhancements, local governments should take into consideration these future precipitation trends and land use information.

2. Data collection is vital to all flood studies, project design and project operation; therefore, the Illinois General Assembly should continue to provide cost share funding to allow for the following: a)maintenance and expansion of the USGS stream and rain gage network by the Illinois Department of Natural Resources; b)continued monitoring of climate and flood data by the Illinois State Water Survey to better validate and fine tune the present climate projections and their effects on urban flooding; and c)continued monitoring of progress in climate model developments and new scientific approaches to account for climate and other uncertainties.

Chapter 3: Technology and Data for Identification of Urban Flooding Potential

Geographic Information Systems (GIS) is a dynamic computerized data system designed to interpolate, analyze, manage, store, and present geographical and spatial information. GIS data that can be applied in the analyses of urban flooding include soils data, topography, land cover and density of urban development, topological wetness index, census data, historical rainfall data, existing infrastructure design, plans, and functionality, and documented flooding problems or flooding.

Hydrologic and hydraulic models, storm sewer assessment models and others similar tools use various data to evaluate flooding potential and design and evaluate stormwater infrastructure. Individual homeowners can also utilize some data to identify flooding issues and corrective actions on their property.

The follow sections provide an overview of technologies and data sources that can be used to evaluate the risk of urban flooding and examples of how these tools can be applied. Many of the data set discussed here were also utilized for the analyses found in the Prevalence and Cost section of this Report. Further analysis and findings may be found in Appendix F.

Key Findings

- Existing data and analyses tools such as GIS can be used for planning to identify areas having the potential for urban flooding.
- Communities can use high resolution topographic data to identify low lying areas.
- While some correlations between data sets can be found, the multiple combinations of factors that can cause urban flooding need to be considered on a case-by-case basis.
- GIS technology provides a ready tool for communities to track the age, location and size of stormwater infrastructure, as well as tracking flooding reports to assist with identifying high risk areas.
- The topographic wetness indices tool provided an accurate depiction of areas susceptible to urban flooding. This tool could be studied and developed further for the identification of urban flooding.

Census Data Analysis

United States Census Bureau compiles the most current census, economic, and governmental boundary data in GIS format in their Topologically Integrated Geographic Encoding and Referencing (TIGER) product and makes it available to the general public (USCB, 2014). The 2014 TIGER dataset includes demographic information from the 2010 census and economic data from 2012.

The TIGER data provides insight into the socioeconomic demographics of the urban landscape. For example, TIGER products can be used in combination with historical flood data, insurance claims data, or public polling to determine the impacts of urban flooding in a community with regard to age, gender, race, median household income, household development, or population density.

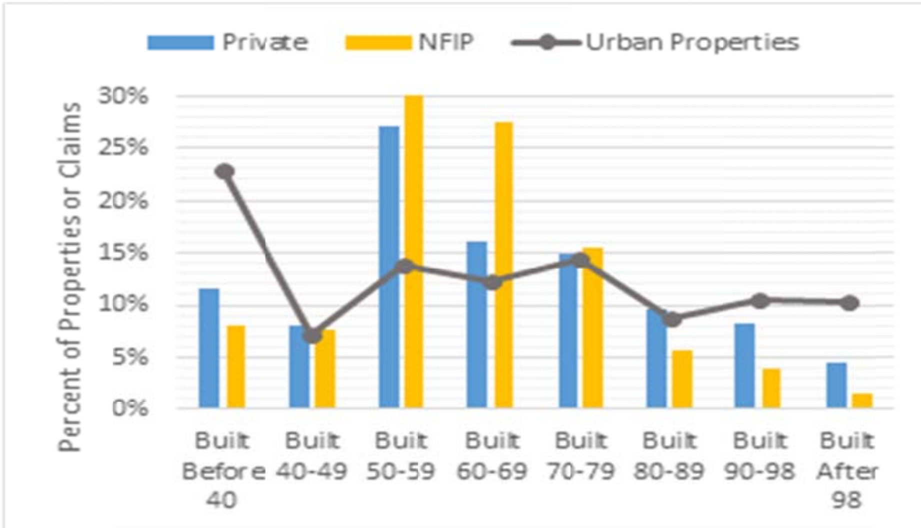


Figure 3.1: Percentage of private and NFIP claims and urban properties with regard to the decade in which the corresponding properties were built.

The TIGER data provides insight into the socioeconomic demographics of the urban landscape. For example, TIGER

An example of the use of TIGER products is provided in Figure 3.1, where the percentage of Private and NFIP claims and urban properties are plotted with regards to the decade in which the corresponding properties were built. Such information can be used in combination with locally specific information to determine the probable locations of urban flooding in a community. It is insightful to note that properties built between 1950 and 1969 while less than 30% of the total building stock, account for more than 40% of private claims and more than 50% of NFIP claims.

Topographic Data/LiDAR

Large scale topographic information is typically developed from light detection and ranging (LiDAR) data, LiDAR can be used to observe drainage patterns on the landscape (Figure 3.2). Airplanes and helicopters are the most commonly used platforms for acquiring LiDAR data over broad areas. Low lying areas can have an increased risk of urban flooding due to limited overland flow paths and susceptibility to ponding.

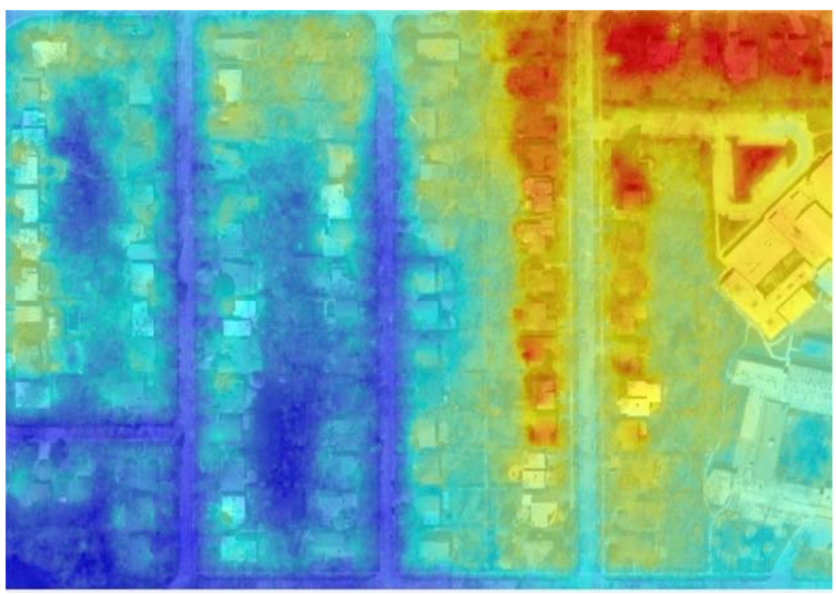


Figure 3.2: LiDAR topography displaying low lying areas (blue) that are susceptible to increased runoff and ponding. An orthophoto of an urban area that is susceptible to urban flooding has been overlaid on a Digital Elevation Model (DEM), a topographic LiDAR derivative.

LiDAR may also be utilized in the development of hydrologic and hydraulic models when producing engineering design plans and creating topographic wetness indices (see discussion of Topographic Wetness Index in this section).

Digital Floodplain Mapping

FEMA initiated the Flood Map Modernization Program (FMMP) in 2003. The goal of the national FMMP was to update paper Flood Insurance Rate Maps (FIRM) flood hazard data and mapping to create an accurate Digital Flood Insurance Rate Map (DFIRM) products to improve floodplain management. In 2010 FEMA initiated the Risk Mapping, Assessment, and Planning (Risk MAP) program to improve upon flood hazard data and mapping at a local and state wide level.

In Illinois 72 counties currently have an effective DFIRM, 6 counties have digital preliminary maps, and 21 counties are still without digital data (Figure 3.3). The digital data developed during these ongoing initiatives can be viewed through the National Flood Hazard Layer (NFHL). The NFHL can be accessed and downloaded through the FEMA Map Service Center.

Urban flooding, which may not be directly attributed to riverine flooding, can and does occur within developed urban floodplains. Floodplain extent, in conjunction with soils, land cover, and existing infrastructure data, help to determine this urban flooding risk.

For example, floodplain data, land cover data, and flood insurance claims data were used to determine the prevalence of urban flooding in relation to riverine floodplains in urban areas of Illinois (See Chapter 1: Prevalence and Cost).

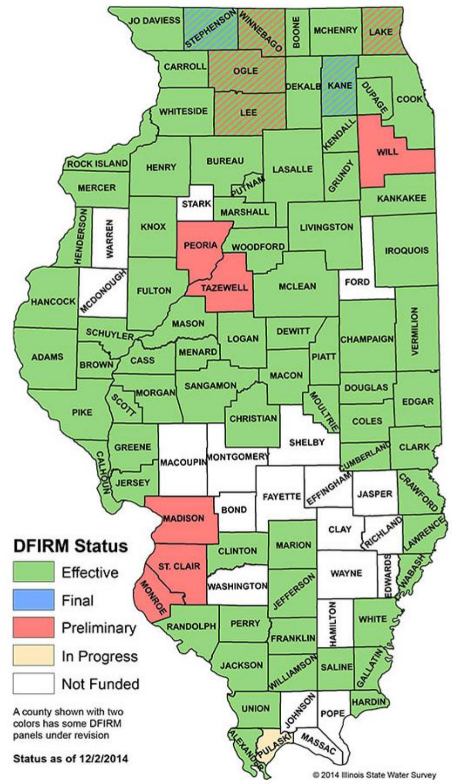


Figure 3.3: Illinois DFIRM Status: In Illinois 72 counties currently have an effective digital flood insurance map (DFIRM), 6 counties have digital preliminary maps, and 21 counties are still without digital data.

Land Cover Data

The National Land Cover Database (NLCD) is a nationwide, satellite-based, 30-meter resolution, land cover dataset. NLCD provides spatial reference and descriptive data for characteristics of the land surface such as urban, agriculture, grassland, and forest and is accessible through the Multi-Resolution Land Characteristics Consortium (Jin et al., 2013). The Multi-Resolution Land Characteristics Consortium (MRLC) has collected and categorized land cover datasets to 1992, 2001, 2006, and 2011.

With regards to urban flooding, this dataset can be utilized to determine urbanization rates, the prominence of land cover types within urban areas, and any correlation to insurance claims or documented locations of repeated flood damages. The land cover dataset could also be utilized for the development of hydrologic and hydraulic model development.

The population increase in Illinois over the course of the past two decades has resulted in a corresponding increase in urban area. Urban development activities such as removing vegetation and soil, grading the land surface, and constructing drainage networks all increase runoff which, with the associated decrease in natural areas to absorb these impacts, exacerbates urban flooding problems.

This expansion of the urbanizing areas can be seen in more detail in Figure 3.5. Figure 3.5 illustrates the land cover change from 1992-2011 within urban areas (as defined in this report). Based on the 2010 census, current urban area is 7.4% (4,170.45 square miles out of 56,349.74 square miles) of the total land area in Illinois. In 1992, within the current urban area, there were 1,815 square miles of land cover classified as developed urban and 2,354 square miles classified as undeveloped (forest, agriculture, et cetera) . In 2011, within the current urban area, there were 3,237.7 square miles of developed urban land cover and 931.4 square miles of undeveloped land cover, a 79.8% increase in developed area. Agricultural fields, wetlands, and forested areas decreased. The total depressional water storage areas and potential riverine areas decreased 14.42%.

Figure 3.4 uses claims data and land cover classifications to display the correlation between the two data sets. Developed land covers 77.67% of the urbanized areas and 99.03% of all insurance claims. The land cover to claim distribution is a follows: High Intensity areas (impervious surfaces account for 80-100% of total cover) consist of 7.48% of the urban area and 2.74% of claims; Medium Intensity areas (impervious surfaces account for 50-79% of total cover) consist of 17.44% of the urban area and 24.86% of claims; Low Intensity areas (impervious surfaces account for 20-49% of total cover) consist of 37.84% of urban areas and 59.44% of claims; open space (impervious surfaces account for less than 20% of total cover) consists of 15.12% of the urban area; open water consists of 2.11% of the urban area, and the undeveloped cover 20.22% of urban areas. As an artifact of the data resolution a small percentage of the claims are assigned to these land use types.

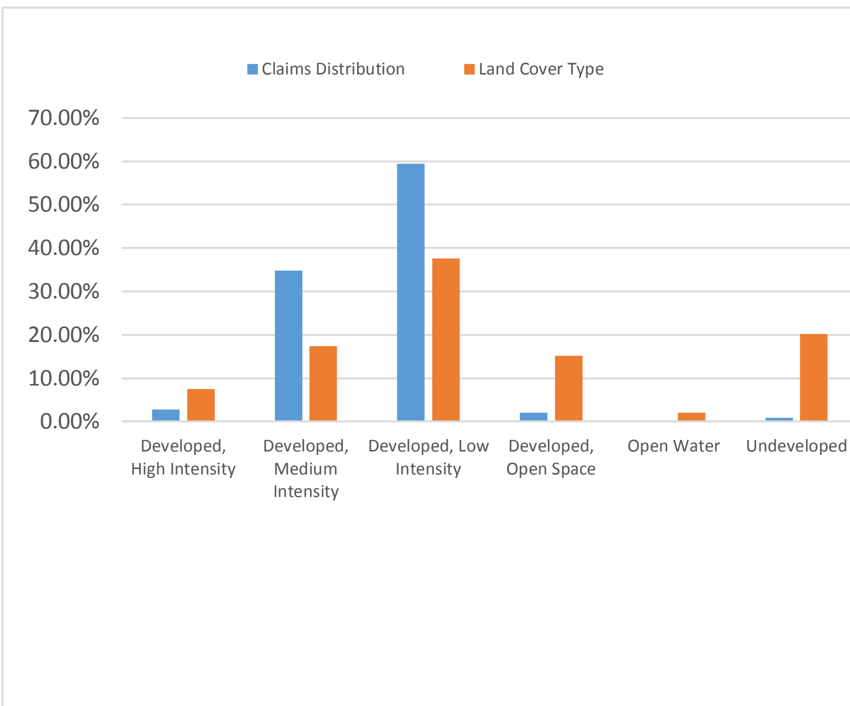


Figure 3.4: The percentage of NFIP and Private insurance claims and the land cover they fall within is shown. The graph also displays the percentage each land cover classification cover in the urban area. Developed land covers 77.67% of the urbanized areas and accounts for 99.03% of all insurance claims.

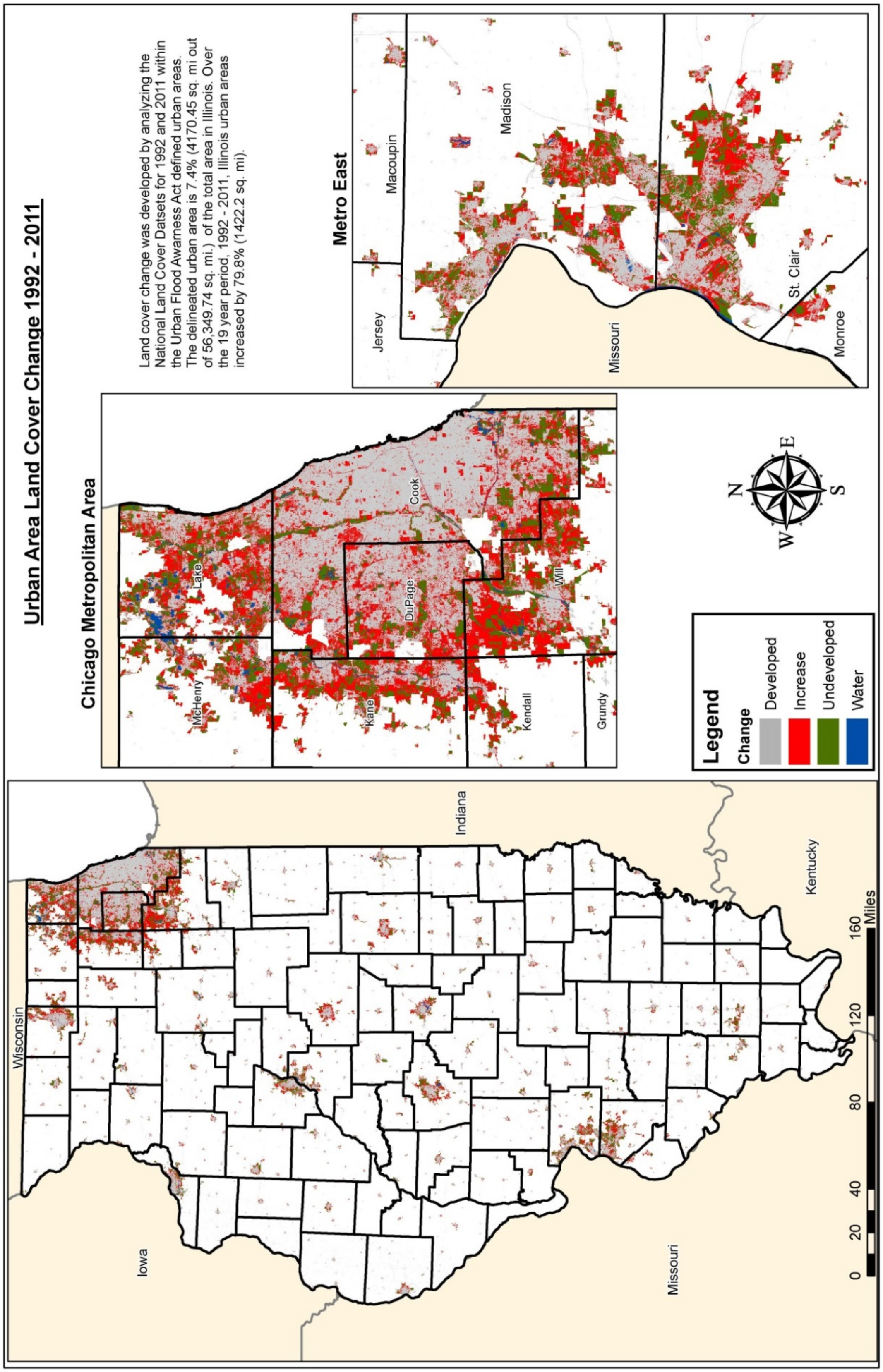


Figure 3.5: Land cover change within the defined urban areas from 1992 - 2011. Over this 19-year period developed areas have increased by 43.9%. Areas in grey represent areas developed in 1992, red represent areas developed as of 2011, blue areas represent water, and green are areas left undeveloped.

The NLCD was further analyzed with the best available 1% annual chance floodplain delineation to determine the number of square miles of development within the floodplain that is located within Illinois urban areas. The digital floodplain data used in these analyses was derived from the following sources: National Flood Hazard Layer (NFHL), preliminary Flood Insurance Rate Maps (FIRMs), and the 21 counties without digital regulatory floodplain data, which were digitized from historical paper FIRMs. Urban areas in Illinois cover 4,170 square miles.

Mapped floodplain covers 11.3% of urban areas (471.14 square miles of 1% annual chance floodplain). About half of the mapped floodplain within the Illinois urban areas, 241.4 square miles, is developed.

Soil Survey Data

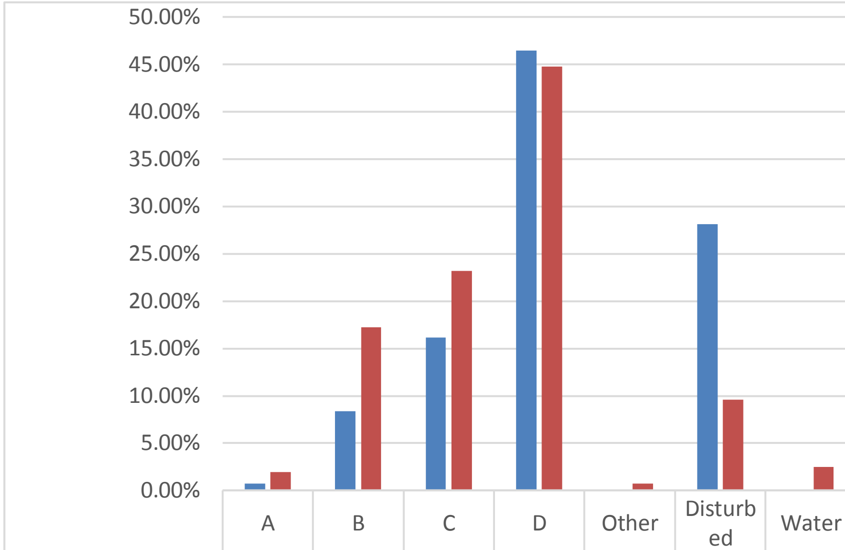
The U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS) Soil Survey has developed a nationwide survey of the soils. These surveys provide descriptions of the soils based on their unique properties. Information gathered from the surveys has been incorporated into a Soil Survey Geographic database (SSURGO), which can be utilized for analyzing various soil attributes through maps and tables.

The SSURGO database contains the hydrologic soil group (HSG) for all soils. The HSG is determined based on a soil's minimum rate of infiltration corresponding to a subsequent period of rainfall. Hydrologic soils groups are split into four groups: A, B, C, and D. These groups are defined in Table 3.1. Through the process of urbanization, soil profiles in metropolitan areas have been significantly disturbed, and their original classifications no longer apply. These areas have been identified by the USDA and reclassified as "urban." Hydrologic soil groups are typically applied in hydrologic modeling when predicting water storage capacities and direct runoff rates of soils. The HSG can also be useful when assessing urban flooding, in identifying areas of flood-prone soils.

Table 3.1: Hydrologic soil groups in Illinois and their infiltration rates. All data from Technical Release 55, Urban Hydrology for Small Watersheds (USDA, 1986)

Hydrologic Soil Group	Description	Texture	Infiltration Rates (inches/hour)
A	Low runoff potential and high infiltration rates even when wetted	Sand, loamy sand, or sandy loam	>0.30
B	Moderate infiltration rates when wetted	Silt loam or loam	0.15-0.30
C	Low infiltration rates when wetted	Sandy clay loam	0.05-0.15
D	High runoff potential and very low infiltration when wetted	Clay loam, silty clay loam, sandy clay, silty clay or clay	0-0.05
Disturbed	Unidentifiable soils in urban areas		

Within the defined urban area 91% of the combined NFIP and private insurance flooding claims are distributed within C, D and Disturbed (urban) soil groupings, which cover 78% of the urban landscape, as seen in Figure 3.6. Hydrologic soil group C and D, soils with very low infiltration and high run off potential, are distributed over 68% of the defined urban area and accounts for 62.65% of the filed flooding claims. The disturbed urban areas, due to increased impervious surface areas, also have a potential for high runoff rates. Disturbed urban areas consist of 28.11% of urban claims distribution and 9.58% of the urban area. With the lack of soil infiltration and high runoff potential, it is highly recommended that below-grade construction be avoided in these areas without special design consideration.



	A	B	C	D	Other	Disturbed	Water
Percent Claims	0.74%	8.42%	16.17%	46.48%	0.02%	28.11%	0.05%
Percent of Area	1.97%	17.26%	23.20%	44.80%	0.72%	9.58%	2.47%

Figure 3.6: Correlation of NFIP and private insurance claims and soil types within the defined urban area.

This analysis suggests that a disproportionate number of claims occur in the urban, disturbed soil group. However, this is a preliminary analysis with various data limitations. Other factors, such as old and inadequate infrastructure, high imperviousness, and economic considerations may have more to do with the high number of urban flooding claims than soil group.

Topographic Wetness Index

The topographic Wetness Index (TWI), also known as the Compound Wetness Index (CWI), is commonly used to estimate soil moisture conditions of a landscape similar to wetland areas. TWI is calculated by evaluating the flow accumulation, slope, and various geometric functions derived from GIS software. The end result is a GIS data layer (raster) that depicts areas with drainage depressions where water is likely to pond. TWI can also identify areas that are susceptible to higher water tables.

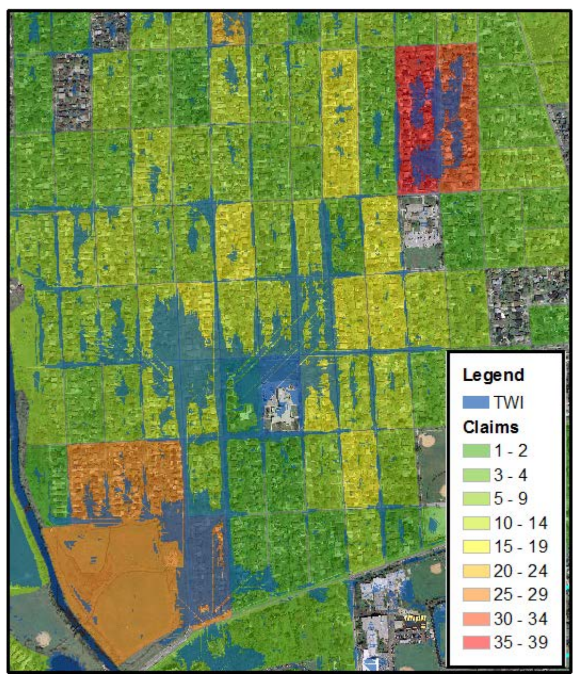


Figure 3.7: Example of a topographic wetness index compiled for DuPage County. The index was overlaid with the claims per census block.

Storm Sewer Infrastructure Spatial Data Inventory

Combined sewers are sewers that carry both sanitary and stormwater flows. During storm events, the combined sewer system can become overwhelmed and discharge the stormwater and sanitary water directly into bodies of water, called Combined Sewer Overflows, or back up into basements and crawlspaces (CMAP, 2008). Even in communities that have dedicated storm sewers, a large percentage of these storm sewers are aging, which increases the risk of flooding due to system failure or inadequate stormwater drainage as drainage demands outpace anticipated demands of outdated systems.

Detailed GIS mapping of existing stormwater infrastructure is a good tool for communitywide stormwater management. Accurate and detailed information about existing systems allows managers and engineers to more easily and cost effectively analyze and model the functionality of those systems. Proposed improvements can also more easily be incorporated and analyzed. Some communities also document and map existing and known flooding or sewer backup hotspots. This information can be used to validate models of the existing stormwater systems and prioritize the application of resources for system improvements. However, gathering accurate information about problem areas is dependent in many cases on the participation and awareness of the public, and databases of detailed information are only as useful as they are accurate.

Engineering Models

Hydrologic and hydraulic models allow engineers to identify flood prone areas by studying how a stream or section of stormwater infrastructure will respond to a given flow event given the current or proposed physical characteristics of a watershed, stream, and/or piece of infrastructure.

Some models are designed to be used with geographic information and drafting systems and have the ability to take into account sewer systems, detention and retention basins (layout, sewer size, materials, manholes, etc.), as well as hydrologic variables (topography, hydrologic soil groups, curve numbers, rainfall durations, etc.) to provide comprehensive analyses of sewer infrastructure.

Results from such models can then be associated with known urban flooding claim locations to determine weaknesses in an urban area's storm sewer infrastructure. These areas can be identified through historic flooding accounts and through the use of GIS to detect hot spot areas. With knowledge of these areas of vulnerability, municipalities can work to make improvements to the infrastructure. Funding options for such improvements can potentially come from sources identified in Chapter 4.

New Technology for Future Research

There are new forms of technology that are improving flood prevention and mitigation. Drones are now being used by some communities, such as the City of Rockford, to examine the extent of flooding in areas that are difficult to access instead of using costly helicopters or planes. Drones can operate more quickly, cheaply, and with greater flexibility than conventional aircraft and can easily send back real-time video to emergency response organizations (Figure 3.8). After recent severe flooding in various parts of the country, drones have assisted post flood by taking aerial photos to make damage assessment maps which help relief agencies coordinate their efforts while other aircraft are grounded due to weather. However, protocols for coordination of airspace with manned and unmanned aircraft need to be further developed. Currently, drones are only cleared by the FAA in limited cases to fly in the U.S., but as of February 15, 2015, the FAA proposed a framework of regulations that would allow routine use of certain small unmanned aircraft systems in today's aviation system (Federal Aviation Administration, 2015).

Figure 3.8: City of Rockford drone. Image courtesy of WREX13 news

Recent advances in remote sensing have enabled communities to better determine when flooding is about to occur in sewers, allowing managers to potentially prevent overflows or to document occurrences to inform future management decisions with real-time monitoring systems that can not only warn of impending sewer overflows but also provide information which enables more efficient management of the collection system as a whole (Quist, Drake, and Hobbs, 2010).

One such application of real-time monitoring is being utilized by the City of Decatur, which is using SmartCover real-time monitoring devices, which attach to the underside of manhole sewer covers and send alerts about impending overflows. This allows community officials to determine when a combined sewer overflow is beginning to flow or discharge water to a larger trunk sewer, providing additional implementation time for the community's emergency response plan.

Recommendations

1. The State of Illinois should provide funding to the Illinois State Water Survey to study and further develop the topographic wetness indices used for the identification of areas likely prone to urban flooding. This would afford communities the ability to identify areas requiring special consideration for below-ground construction.
2. Communities should consider real-time monitoring of combined storm sewer systems. When technology allows, they should update the monitoring with a reverse 911 system to alert property owners of imminent flooding.
3. Within a reasonable timeframe, communities should update their storm sewer atlas with storm sewer location, infrastructure sizes and design data to allow for evaluation of the effect of changing rainfall patterns on system capacity to more accurately identify areas at risk for urban flooding, and to better inform stormwater management planning.
4. Communities should consider adoption of ordinances to address drainage for below-grade construction, such as requiring sewers to exit structures within 2 to 3 feet of the finished exterior grade of buildings. Adoption of International Building Code Sections R405 and R406 for foundation drainage and waterproofing should also be considered.

Section 2

Effectiveness of Projects, Programs and Policies

This section examines current programs and practices at the community, county, state and federal level to explore their effectiveness. The first chapter includes a review of current stormwater management practices that are commonly adopted by communities and counties with an explanation of the rationale for current design standards. A review of countywide stormwater management programs that have been operational for a number of years provides insight into successes. This section concludes with an overview of state and federal programs that may impact urban flooding solutions.

Chapter 4: The Impact of Countywide Stormwater Programs on Urban Flooding over the Past Two Decades

Key Findings

- A number of counties with countywide stormwater management authority have profoundly impacted urban flooding through a myriad of programs and projects aimed to reduce stormwater runoff.
- Current county stormwater ordinances have common elements including providing safe passage for the 1% annual chance event, retaining runoff on-site, and requiring stormwater management for a certain area of disturbance or new impervious.
- Countywide stormwater management programs are able to address more efficiently stormwater program management issues in urban areas (e.g. permitting, inspections) than individual small communities, especially in a highly developed urban area.
- Counties are better able to facilitate watershed-based analysis of stormwater management issues.
- Counties have successfully implemented sources of funding that may not be viable for small communities.

Stormwater management in Illinois must be authorized by state legislation for county governments to possess the legal authority to manage stormwater in both unincorporated and incorporated areas, a.k.a. countywide authority. In the State of Illinois, the code currently used by authorized counties is 55 Illinois Compiled Statutes (ILCS) 5. Legislation 55 ILCS 5/5-1062 refers to the stormwater management authority that qualified counties may have. The purpose of the section is to "allow management and mitigation of the effects of urbanization on stormwater drainage in metropolitan counties located in the area…." The purpose is attained by three clear objectives: "(1) consolidating the existing stormwater management framework into a united, countywide structure, (2) setting minimum standards for floodplain and stormwater management, and (3) preparing a countywide plan for the management of stormwater runoff, including the management of natural and man-made drainageways. A stormwater management planning committee shall be established to oversee the implementation of stormwater management in the county."

Sixteen counties have the state-granted authority to manage and mitigate the effects of urbanization on stormwater drainage; they include: Boone County, Cook County (via the Metropolitan Water Reclamation District of Greater Chicago, authority does include the City of Chicago), DeKalb County, DuPage County, Grundy County, Kane County, Kankakee County, Kendall County, Lake County, LaSalle County, Madison County, McHenry County, Monroe County, Peoria County, St. Clair County, and Will County. Of the sixteen counties with authorization to manage stormwater, fourteen of them currently have stormwater ordinances. The remaining two counties (Grundy and LaSalle Counties) are presently developing ordinances for stormwater management. See Figure 4.1.

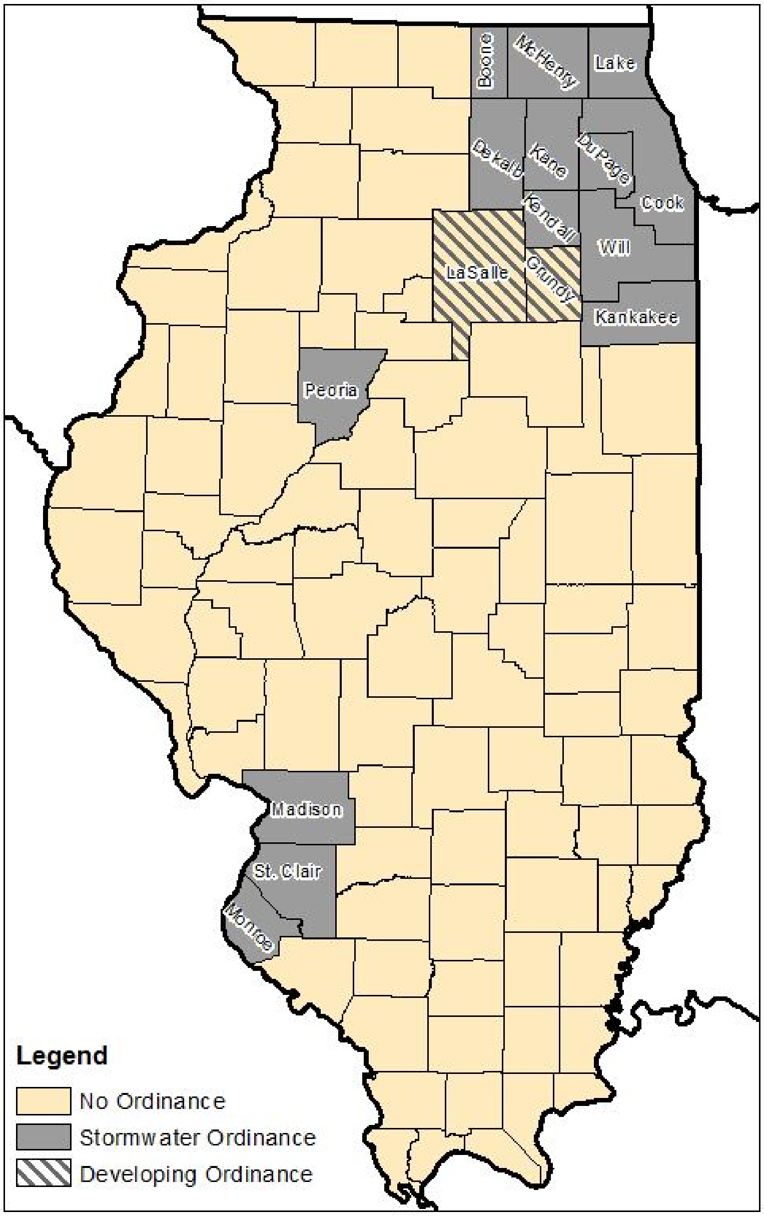


Figure 4.1: Counties indicated in gray have stormwater ordinances. Counties indicated with a hatch pattern are developing stormwater ordinances. The remaining counties are those without authorization to manage stormwater drainage.

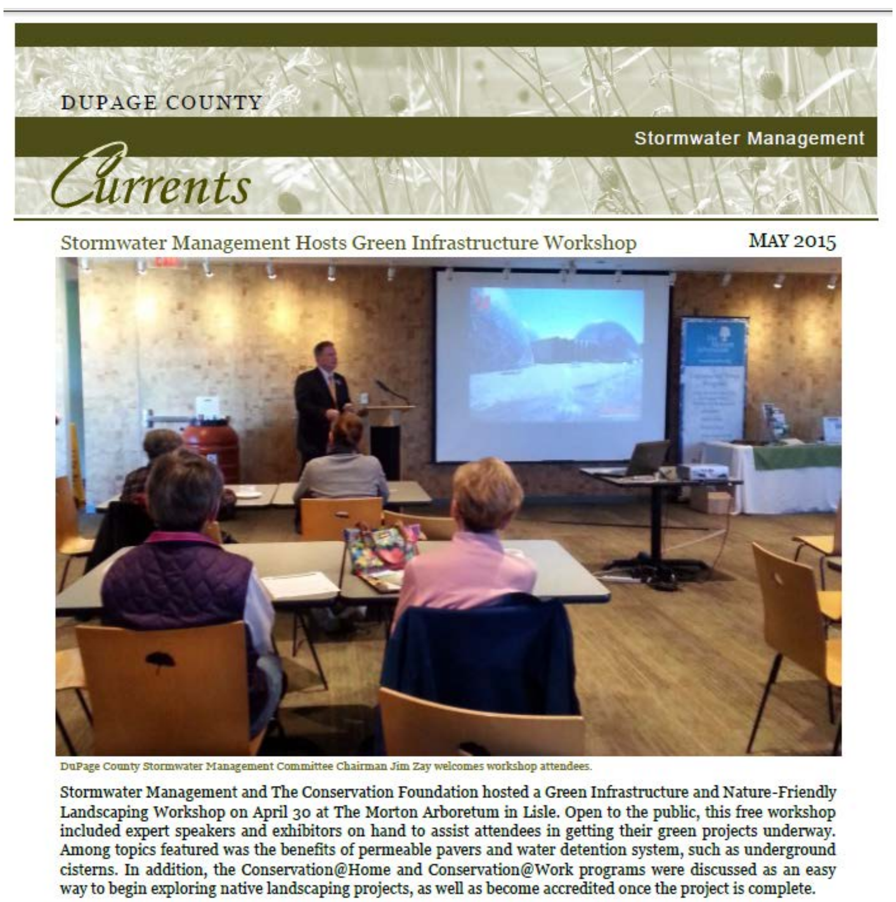
Of the 102 Illinois counties, there are 86 counties that do not have authorization to manage and mitigate the effects of urbanization on stormwater runoff. The counties that do have stormwater management authorization are listed in Table 4.1. The specific legislation granting stormwater management authority is included as well as the stormwater ordinance date (if applicable) and the date of the most recent ordinance revision.

A number of the counties with authorization to manage stormwater have implemented programs, projects and regulations to prevent flooding, mitigate stormwater, and improve water quality. The following counties have profoundly impacted urban flooding through a myriad of programs and projects aimed to reduce stormwater runoff: Cook, DuPage, Grundy, Kane, and Lake Counties. Some of these projects were initiated under authorities other than those granted under the Stormwater Management Authority (55 ILCS 5/5-1062). Boone and Peoria Counties do not have any active programs or projects, because currently the municipalities within each county have stricter stormwater management plans than the county.

Many counties have initiated stormwater programs. A summary of all projects, programs, and regulations for the sixteen counties with stormwater authorization is found in Appendix G. The counties which have been most active have had the authority for the longest time.

Table 4.1: Counties with stormwater ordinances, the legislation that grants them authorization to provide stormwater management, and the date of their current ordinance and any subsequent revisions.

County Name	Legislation	Ordinance (y/n)	Date of Ordinance	Date of Revised Ordinance
Boone	55 ILCS 5/5-1062.2	n	NA	
Cook (MWRD has authority)	70 ILCS 2065/7h	y	2014	2014
DeKalb	55 ILCS 5/5-1062.2	y	2006	2010
DuPage	55 ILCS 5/5-1062	y	1991	2013
Grundy	55 ILCS 5/5-1062.2	n	NA	
Kane	55 ILCS 5/5-1062	y	2000	2009
Kankakee	55 ILCS 5/5-1062.2	y	2006	
Kendall	55 ILCS 5/5-1062	y	2015	
Lake	55 ILCS 5/5-1062	y	1992	2013
LaSalle	55 ILCS 5/5-1062.2	n	NA	
Madison	55 ILCS 5/5-1062.2	y	2000	2007
McHenry	55 ILCS 5/5-1062	y	2004	2014
Monroe	55 ILCS 5/5-1062.2	y	2004	2006
Peoria	55 ILCS 5/5-1062.3	y	1994	2013
St. Clair	55 ILCS 5/5-1062.2	y	2009	
Will	55 ILCS 5/5-1062	y	2004	2010


DUPAGE COUNTY
Stormwater Management
Currents

Stormwater Management Hosts Green Infrastructure Workshop

MAY 2015

DuPage County Stormwater Management Committee Chairman Jim Zay welcomes workshop attendees.

Stormwater Management and The Conservation Foundation hosted a Green Infrastructure and Nature-Friendly Landscaping Workshop on April 30 at The Morton Arboretum in Lisle. Open to the public, this free workshop included expert speakers and exhibitors on hand to assist attendees in getting their green projects underway. Among topics featured was the benefits of permeable pavers and water detention system, such as underground cisterns. In addition, the Conservation@Home and Conservation@Work programs were discussed as an easy way to begin exploring native landscaping projects, as well as become accredited once the project is complete.

Figure 4.2: Countywide programs provide training opportunities such as workshops on green infrastructure.

Figure 4.3: The Round Lake Drain ecosystem restoration project is an example of a flooding mitigation project in Lake County. Photos courtesy of Lake County Stormwater Management Commission.

County Ordinances and Standards

The elements within each county's stormwater ordinance are similar. The design storm used for the stormwater conveyance system, detention requirements, and applicability for a stormwater permit are listed in Table 4.2. Counties either use the 100-year (1% annual chance) event or the 10-year (10% annual chance) event for the stormwater system design. The counties specifying the 10-year event require a safe overflow pathway for the 100-year event as well. The total precipitation over a 24-hour period that is expected to occur on average once every 100 years, is commonly referred to as the 100-year, 24-hour storm event. It is common to use this event for stormwater detention requirements. The thresholds for a stormwater permit requirement are somewhat varied, though several counties use 5,000 square feet, 10,000 square feet, or 1 acre as developed-area thresholds.

Overall, the ordinances, programs, and projects established by the counties given authority to manage stormwater provide a framework for controlling urban flooding. Stormwater runoff is controlled through the ordinance and permitting structure. Problem areas are targeted with specific projects and programs designed to reduce urban flooding and property damage.

Table 4.2: County Stormwater Ordinance summary of common elements

County	Design storm for stormwater systems	Retention/ Detention Requirements	Area of Development Thresholds			
			Residential	Multi-family	Non-Res	Open Space
Cook	100 year	First inch of runoff from impervious area = volume control storage	1 acre	0.5 acre	0.5 acre	0.5 acre
Kane	100 year	0.1 cfs/acre detention + 0.75" rainfall over impervious area of new development	2 or more homes on 3 or more acres	1 acre	1 acre	
DuPage	100 year	Pre-development peak discharges in a 2 year, 24 hour and 100 year event of critical duration up to a 24 hour duration	5,000 square feet, or 2,500 square feet of net new impervious			
Will	100 year	100 year, 24 hour	1 acre	1 acre	1 acre	1 acre
Lake	10 year	0.04 cfs/acre for the 2-year, 24-hour event; and 0.15 cfs/acre for the 100-year, 24-hour event	5,000 square feet of hydrologic disturbance; activities within a floodplain or create a wetland impact; drainage modifications with twenty (20) or more acres of tributary drainage area			
DeKalb	10 year	100 year, critical duration	Any land disturbing activity affecting more than 10,000 square feet; land disturbing activity within 100 feet of a waterway			
Kankakee	10 year	100 year	Construction adding more than 500 square feet of impervious surface, land disturbing activity affecting more than 5,000 square feet, activity within 25 feet of a waterway			

County	Design storm for stormwater systems	Retention/ Detention Requirements	Area of Development Thresholds			
			Residential	Multi-family	Non-Res	Open Space
Kendall	100 year	100 year, 24 hour	< 3acre	45,000 square feet of development or 32,000 square feet of impervious area		
Madison	100 year	100 year, 24 hour	10,000 square feet total impervious surface; any activity disturbing 10,000 square feet; any activity within 25 feet of a waterbody; any activity on a slope			
McHenry	10 year	100 year, critical duration	Development disturbing 5000 square feet or more; 50% or more of a parcel; 20,000 square feet additional impervious; or within a flood hazard area or wetland.			
Monroe	100 year	pre-development = post-development runoff	Any new development or redevelopment that will meet or exceed 5,000 square feet of total impervious surface; any land disturbance activity in excess of 5,000 square feet located in a business or industrial zoning district			
Peoria	2 year, 25 year	pre-development = post-development for 2-year and 25-year events	Land disturbing activity disturbing more than 5,000 square feet			
St. Clair	2 year,	100 year, 24 hour	Any new development or redevelopment that will meet or exceed 10,000 square feet of total impervious surface; any land disturbance activity in excess of 1 acre of land; land disturbing activity within 25 feet of any waterway			

County stormwater management programs are able to address stormwater program management issues at a larger scale than many small communities, especially in a highly dense urban area. Some county programs, such as those of DuPage and Lake Counties, provide permitting and regulation only when communities choose not to administer the program themselves. Many small communities benefit from a county's efficient use of resources to support and enforce stormwater regulation and avoid competitive lowering of stormwater management standards for economic benefit. Counties are better able to facilitate watershed-based analysis of stormwater management issues. Counties have successfully implemented sources of funding that may not be viable for small communities.

Figure 4.4: Countywide stormwater management can provide efficiencies for administration and enforcement of ordinances.

While county management provides many benefits for small communities in urban areas, there are limitations to addressing flooding caused by existing municipal infrastructure or a lack of overflow drainage path. Counties with stormwater management programs do not have jurisdiction over municipal sewer systems. Even the most active county stormwater programs typically stop short of addressing local storm and sanitary sewer issues that can cause urban flooding damages outside of the floodplain. County programs, including capital improvements and flood reduction strategies, generally address riverine flooding. While counties with stormwater management authority provide a support framework, the responsibility for maintenance of local stormwater infrastructure, such as storm sewers and combined sewers, still falls on the municipality.

In general, the aspect of county stormwater management programs with the most impact on stormwater flooding in urban areas is proactive design requirements for new development. Other programs addressing reduction of urban flooding outside of the floodplain vary by county. Some counties provide outreach about urban flooding risk or engineering analysis to support local flood reduction actions. Green infrastructure programs (see Chapter 9) in previously developed areas reduce local rainfall runoff volume. The Cook County Stormwater Management Plan Amendment recently provided the Metropolitan Water Reclamation District of Greater Chicago authority to allow planning, implementation and funding of local stormwater drainage projects, and several projects that will reduce urban flood damages are underway. The Kane County Cost Share Program provides funding to alleviate local urban flooding.

Stormwater Program Funding

A variety of funding mechanisms are used to support county stormwater programs. The access to property or other taxes and the use of these funds is dependent upon the specific authority of the program under the adopted ordinances and the specific authority of the local government. Agreements and responsibilities between the county and a community can vary. Kane County is in the unique position to use revenue from riverboats where gambling is permitted.

Recommendations

1. The authority to generate revenue from fees, to plan, implement and maintain stormwater management/drainage programs/facilities should be granted to all County Stormwater Planning and Management Agencies (55 ILCS 5/5-1062), counties (55 ILCS 5/Div. 5-15) and municipalities regardless of home rule status.
2. Stormwater Planning and Management authority should be granted to all Illinois counties to adopt countywide stormwater ordinances, projects and programs.
3. The Illinois Department of Natural Resources and Illinois State Water Survey should develop a state model local stormwater ordinance based on concepts in the report which can be used as a template by counties and local communities. The following should be included along with other actions to address urban drainage issues:

a. Incorporate green infrastructure into municipal and county development regulations by modifying regulations that restrict use of green infrastructure and add regulations to encourage use of green infrastructure in capital improvement projects when possible.
b. Stormwater infiltration, evapotranspiration and storage should be incorporated into new development and redevelopment wherever possible.
c. Developers and property owners should be incentivized to dedicate property for increased open space in developing areas, and current open space should be protected to allow for evapotranspiration, infiltration and stormwater storage.
d. Require a licensed plumber to inspect for sump pump and downspout connections to sanitary sewers when houses are sold.

Chapter 5: Evaluation of Design Standards for Stormwater Infrastructure

Stormwater runoff from precipitation or snowmelt can cause local flooding and flood related damage. Urbanization often increases the rate and volume stormwater runoff due to decreases in infiltration, and evapotranspiration. Storm sewer systems are constructed to collect and convey runoff from developed areas to minimize damages and inconvenience and keep transportation avenues open. A consequence of storm sewers efficiency is the delivery of higher peak runoff and larger volumes of runoff to streams and rivers and increased flooding. One of the goals of stormwater management which emerged in the 1970s is to reduce the peak runoff rate to streams and rivers and in some locations the runoff volume. Detention basins are commonly used to detain flow to reduce peaks and retention basins hold water on site to reduce water volume delivered to natural streams and rivers. Stormwater detention and retention is expected to mitigate the increase in peak flows and volume downstream in the watershed due to development upstream. Water quality can also be addressed as part of stormwater management.

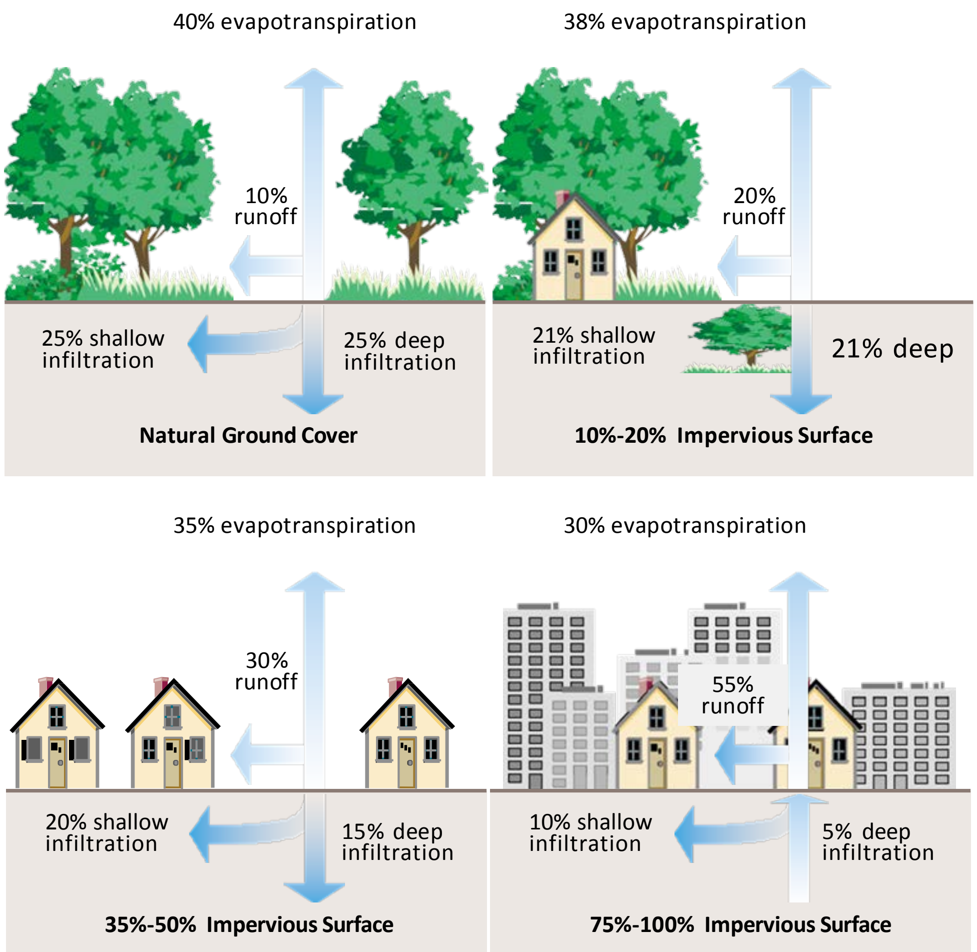


Figure 5.1: The effects of urbanization on evapotranspiration, infiltration, and total runoff (FISRWG, 2001).

Key Findings

- Safety, cost, and tolerance of the stormwater system capacity being exceeded and the resulting flooding are all considerations when a community sets design standards.
- The selection of a source for data used in design storm approach can greatly affect the design, functionality, and lifespan of the stormwater infrastructure. In some areas, a sewer designed to convey the 10-year storm based on rainfall data through 1960 would only carry the 6.6-year rainfall estimated from a data set extending to the 1980s.
- As more data is collected over the years, the expected values of rainfall for various durations and return periods may change, particularly for extreme events such as those having a 100-year return period.
- Stormwater design standards and implementation vary across the state:
    - Northern Illinois typically uses 10-year design storms for minor conveyance systems and dual-uniform stormwater release rates. Stormwater ordinances are implemented by the county, though the municipality can implement more restrictive requirements.
    - Southern and Central Illinois mandate 5-year or 10-year (sometimes 2-year) design storms for minor conveyance systems and post-development release rates are based on pre-development release rates. Stormwater ordinances are implemented by municipalities.
- The majority of detention facilities throughout Illinois are sized based on the 100-year, 24-hour design storm.
- Stormwater ordinances are generally focused on new development areas. Redevelopment and infill are not typically addressed in as much detail.
- While there are exceptions in Illinois, stormwater runoff volume reductions are not universally addressed in stormwater ordinances nor are techniques to achieve volume reduction.

Design Standards and Rainfall

Contemporary urban stormwater systems are commonly designed to have the capacity to convey events that occur on average once in five years or once in ten years. Excess runoff, which can result in flooding, is expected during larger events that would happen less frequently, e.g. 25–year, 50-year or 100-year events. Infrastructure with the capacity to convey these larger but less frequent events would require a larger conveyance system (pipes) and significantly higher costs than a system designed to convey relatively smaller, more frequent events.

Safety, cost, and tolerance of the system capacity being exceeded and resulting flooding are all considerations when a community sets design standards.

Design standards are not the same across the country, within a state, or even between contiguous municipalities but tend to be similar. Most current design standards were originally established at the recommendation of groups of experts in the 1960s-1970s and continue to be reviewed and debated today (ASFPM, 2004).

Design Storms

The design discharge is computed based on a design storm event (a design storm event used to compute the design discharge). Design storm events are typically defined by rainfall duration, total rainfall amount, and temporal distribution of rainfall in addition to the return period (as described above). The 10-year, 2-hour design storm was selected for examination in this report as representative of storm sewer design, and the 100-year, 24-hour storm is typical for detention basin design within Illinois.

RETURN PERIOD
Frequency of Occurrence in Hydrology

The return period is a way of expressing that the design discharge is expected to be equaled or exceeded on average once in the specified number of years, for example the 10-year rainfall. In the long term, the 10-year rainfall is expected to be equaled or exceeded 1 time in 10 years. It could happen 2 years in succession, then not again for 18 years. This can also be expressed as a probability, such as a 10% annual chance of occurrence, meaning it has a 10% chance of being equaled or exceeded every year.

Rainfall data are used to compute discharge and thus stormwater infrastructure size. Rainfall intensity-duration estimates are based on statistical analyses of long-term rain gauge data. The earliest published and widely used rainfall intensity duration data was the National Weather Service's "Technical Paper No. 40, Rainfall Frequency Atlas of the United States" (TP-40) (Hershfield, 1961). The rain gauge records spanned 1938-1957. The next source of intensity-duration estimates comes from the Illinois State Water Survey's "Bulletin 70: Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois" (Huff and Angel, 1989). The rain gauge records spanned 1901-1983. The latest published source of rainfall intensity-duration estimates is the National Oceanic and Atmospheric Administration's "Atlas 14: Precipitation-Frequency Atlas of the United States, Volume 2, Version 3.0: Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia" (Bonnin et al., 2006). The rain gauge records spanned 1891-2000.

Based on a statewide review, the current widely accepted state standard for rainfall intensity duration data is Bulletin 70. The Illinois Department of Natural Resources, Office of Water Resources requires the use of Bulletin 70 hydrology for flood studies requiring state permits, and most stormwater ordinances in Illinois recommend the use of Bulletin 70 for design. The Federal Emergency Management Agency likewise requires Bulletin 70 hydrology when mandated by the state. The Illinois Department of Transportation also recommends the used of Bulletin 70 precipitation for all hydrologic methods and modeling. However, prior to the publication of Bulletin 70 in 1989, the National Weather Service publication, Technical Paper No. 40, was the source of design rainfall data.

Prior to the publication of rainfall frequency estimates, design practices varied widely. Older areas of communities typically were designed with combined sanitary and storm sewers. Stormwater systems and infrastructure designed and constructed roughly between 1961 and the late 1980s is based on TP40 rainfall data. Cook County used TP40 data until 2014.

TP40 results are based on precipitation data that span a relatively dry period as compared to subsequent decades. In many areas of Illinois, the expected depth of rainfall during a less frequent (larger) storm event given in TP40 is less that the expected rainfall based on the results for the longer period of record presented in Bulletin 70. A comparison of TP40 and Bulletin 70 is provided in Figure 5.2 for the 10-year, 2-hour and 100-year, 24-hour events. In areas where Bulletin 70 rainfall depths are greater than TP40 rainfall depths, it is likely that storm sewer systems designed using TP40 data would be considered undersized based on Bulletin 70 data, the outcome being the system capacity would be exceeded more frequently than anticipated.

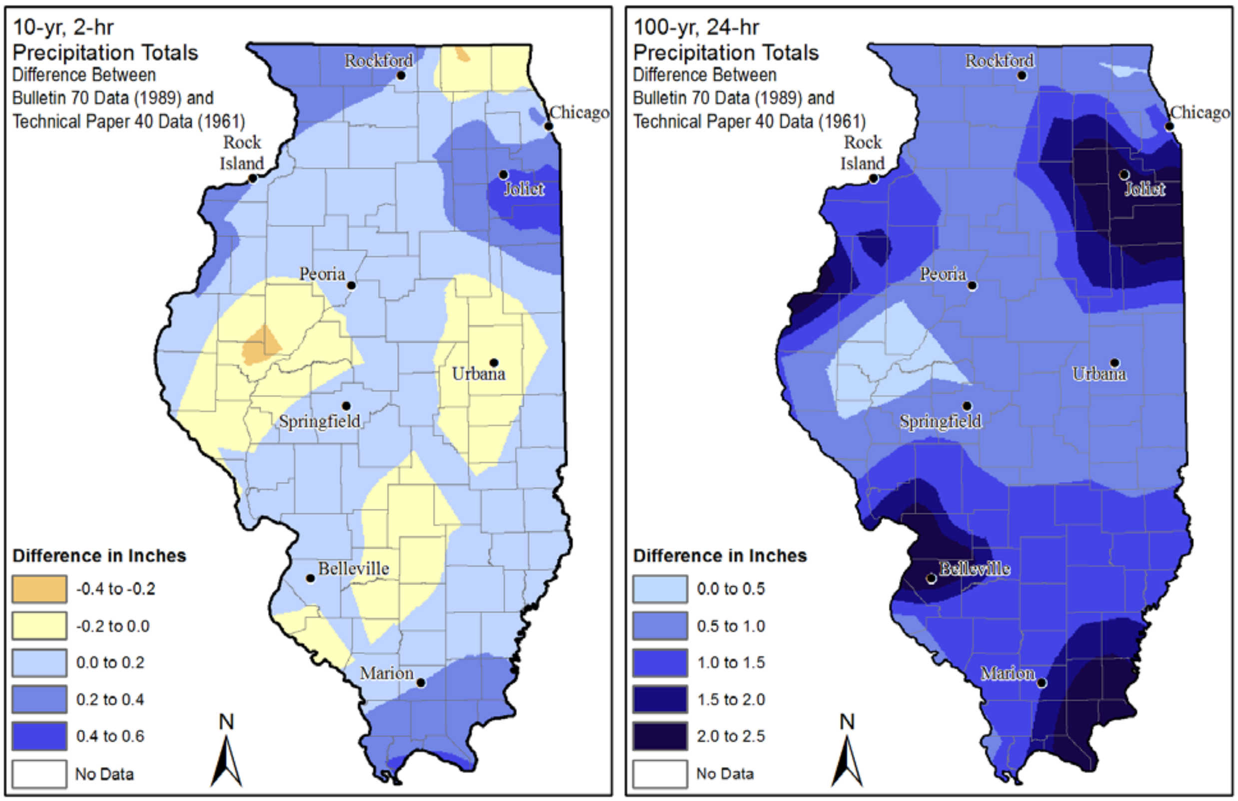


Figure 5.2: Differences between Bulletin 70 and TP-40 for the 10-year, 2-hour and 100-year, 24-hour design storms. Blue shows areas where Bulletin 70 has higher rainfall totals; yellow shows where TP-40 has higher totals. TP-40 shows lower rainfall totals than Bulletin 70 for the 100-year, 24-hour event across Illinois while the rainfall totals for the 10-year, 2-hour event are similar (within 0.5 inches).TP-40 was based on a shorter record earlier in the 20th century, which did not include large storms characteristic for the period after the 1950s.

Table 5.1 shows a comparison of average rainfall amounts recorded at O'Hare Airport in Cook County for the 10-year, 2-hour and 100-year, 24-hour design storms for TP-40, Bulletin 70, and Atlas 14. The 10-year, 2-hour design storm is generally representative for storm sewer design and the 100-year, 24-hour storm is typical for detention basin design within Illinois.

Table 5.1: Precipitation intensity-duration estimates for Northeastern Illinois (O'Hare Airport)

Design Storm	TP-40 (inches)	Bulletin 70 (inches)	Atlas-14 (inches)
10 year – 2 hour	2.37	2.64	2.48
100 year – 24 hour	5.75	7.58	7.22

The selection of a source for data used in design storm approach can greatly affect the design, functionality, and lifespan of the stormwater infrastructure. As indicated in Table 5.1, a storm sewer designed to accommodate the TP-40 10-year, 2-hour storm event would correspond to a sewer designed to convey only the 6.6-year, 2-hour Bulletin 70 design storm. A detention basin sized to accommodate the TP-40 100-year, 24-hour storm event would accommodate only the 31.3-year, 24-hour Bulletin 70 design storm. Compared to Atlas 14 rainfall values, the stormwater infrastructure would be designed to accommodate the 8-year, 2-hour and the 84-year, 24-hour Bulletin 70 design storms, respectively. This illustrates that stormwater infrastructure, which was designed properly based on one set of intensity-duration estimates may be undersized (10-year vs. 6.6-year design storm) compared to a design based on another set of intensity-duration estimates.

Stormwater infrastructure design is based on design storms derived from statistical analyses of observed rainfall. As more years of observation data become available, the inches of rainfall associated with recurrence intervals, e.g. 10-year storm, can change. The comparison of TP-40, Bulletin 70 and Atlas 14 indicates that rainfall and thus design storms is increasing in areas of Illinois. Bulletin 70 analyses, although similar to the tools used by the National Weather Service, takes into account known irregularities in precipitation and provides a finer tuned estimation of rainfall intensities and durations. It should continue to be used for stormwater infrastructure design; however, with 30 years of additional data available, an update of Bulletin 70 should be performed.

Existing Storm Sewer Design Standards in Illinois

In Illinois, the ordinances regarding stormwater system design vary across the state. In northeastern Illinois the standard requirement based on a review of local ordinances is for minor systems to convey the 10-year event and for major systems to convey the 100-year event. Outside of the Chicago Metropolitan Area, municipal requirements vary between the 5-year and 10-year events (a few require conveyance of a 2-year event) for minor systems; and the 50-year and 100-year events for major systems. The standards vary across the state. The Illinois Department of Transportation also requires minor conveyance systems along state roads to convey the 10-year event; depressed areas where runoff can only be removed by a storm sewer should be designed to convey the 50-year event. In addition, consideration should be given to traffic volume, type and use of roadway, speed limit, flood damage potential, and the needs of the local community (IDOT, 2011).

Evolution of Design Standards

Storm sewer design standards have changed over the years and these changes are apparent across Illinois urban areas. In the oldest urban areas, stormwater is often drained by combined sewers, which carry both wastewater and stormwater. Slightly newer areas may be drained by storm sewers designed for the 2-year event. The newest areas of a town may be drained by storm sewers designed for the 5-year or 10-year events. In this way, Illinois towns represent the evolution of stormwater conveyance system design. With time, information on rainfall has increased and expected values of rainfall for design storms have changed.

Existing Detention Release Rates Standards in Illinois

Figure 5.3: Regional detention basin in Champaign, IL. Photo courtesy of FOTH.

Many communities have adopted ordinances to require that new developments manage runoff from the developed area such that pre-development runoff peaks are not exceeded. To accomplish this requirement, detention basins are often constructed to detain runoff and slowly release it. The design standard for a detention facility and outlet structure is commonly expressed as an allowable release rate for a specified return interval event; for example, release from the structures shall not exceed 0.3 cfs per acre of development during a 100-year event, and the peak discharge from the detention structure must be less than pre-development 100-year peak discharge. How and why the prescribed release rate is determined and the corresponding magnitude varies regionally across Illinois. Figure 5.4 illustrates the impact on discharge downstream of a detention pond.

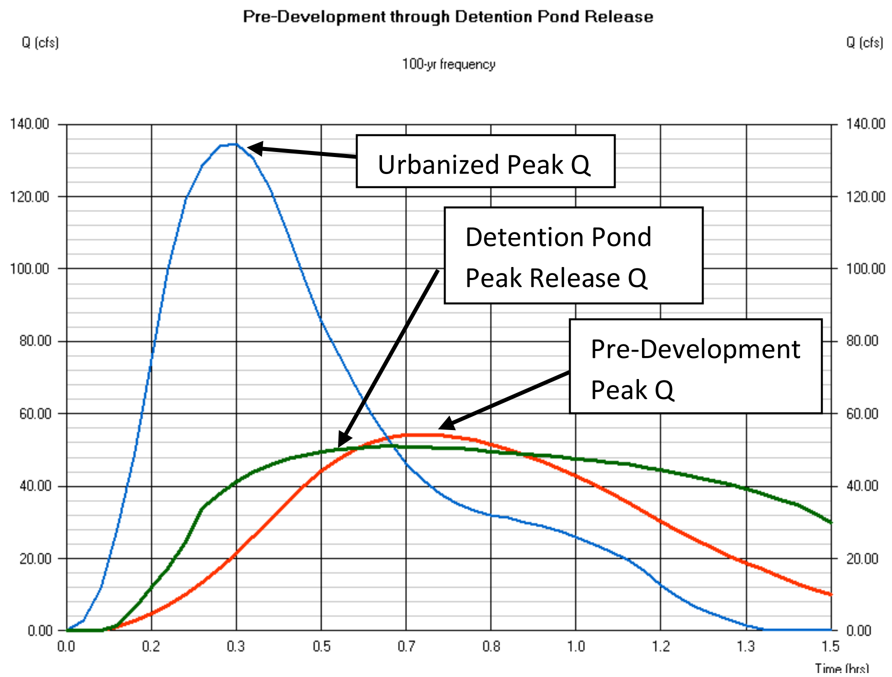


Figure 5.4: Pre-development (red), post-development (blue), and detention pond (green) hydrographs. The peak discharge increases due to urbanization and is reduced below pre-development conditions by the detention pond. The volume of runoff increases between the pre-development conditions and runoff released by the detention pond.

In northeastern Illinois, uniform stormwater release rates (such a 0.1 cfs/acre) have become standard and are implemented on a countywide basis as opposed to municipal-specific stormwater ordinances. In 1989, the Chicago Metropolitan Agency for Planning (CMAP) (formally Northeastern Illinois Planning Commission, NIPC) released a report call "Evaluation of Stormwater Detention Effectiveness in Northeastern Illinois," which led to the implementation of uniform stormwater release rates in northeastern Illinois (Dreher et al., 1989 and Dreher and Price, 1991). The study showed that detention basins designed to limit the design storm runoff peak (100-year event) to pre-development conditions resulted in increased downstream peaks in the northeastern Illinois area due to the large volume of stormwater runoff and coincident hydrographs downstream. From the study, CMAP recommended the implementation of a more restrictive uniform release rate (Maki, 2007b). CMAP determined that if local peak runoff is controlled below the pre-development runoff rate, then downstream peaks could more closely represent pre-development conditions for that event. CMAP released a Model On-Site Stormwater Detention Ordinance in which a dual-uniform release rate of 0.04 cfs/acre for the 2-year event and 0.15 cfs/acre for the 100-year event is suggested (CMAP, 1990 and 1994). Kendall County, Lake County, McHenry County, and Will County currently use these dual-uniform release rates. DuPage County uses a single uniform release rate of 0.01 cfs/acre for tributary areas under 100 acres and a dual standard for developments with a tributary area 100 acres or greater, and Kane County use a single-uniform release rate of 0.1 cfs/acre for the 100-year event. Municipalities within these counties can impose more restrictive stormwater release rate limits as desired.

The Southwestern Illinois Planning Commission (SIPC), which serves Madison, St. Clair, and Monroe Counties, produced a model ordinance similar to the CMAP model ordinance, which included the same dual-uniform release rates of 0.04 cfs/acre and 0.15 cfs/acre for the 2-year and 100-year events, respectively (SIPC, 1997). However, the dual-uniform release rates have not been widely implemented by the counties or local municipalities, where most ordinances refer to pre-development conditions.

Existing Volume Reduction Standards in Illinois

Modern stormwater ordinances have generally been effective at controlling the rate of stormwater runoff but have limited impact on reducing the total volume of runoff (CMAP, 2008). Detention basins can capture increased stormwater volume due to development and reduce the peak discharge, but eventually the extra stormwater volume is released downstream (Maki, 2007a). Reducing the volume of stormwater runoff can be especially important in areas with combined sewers. Combined sewers are sewers that carry both sanitary and stormwater flows. During storm events the combined sewer system can frequently become overwhelmed and discharge the stormwater and sanitary water directly into bodies of water, called Combined Sewer Overflows (CSOs), or back up into basement and crawlspaces (CMAP, 2008). If the amount of stormwater runoff can be reduced, the number of CSO discharge events and sewer backups can also be reduced.

Stormwater volume can be reduced by minimizing impervious surfaces on developed properties, infiltrating runoff on-site, and promoting temporary storage for secondary uses, such as irrigation. Several counties in northeastern Illinois, including DuPage, Kendall, Lake, and McHenry, have included a runoff volume reduction hierarchy in their countywide stormwater ordinances. Several other counties such as Kane County have included a list of best management practices (BMPs) for stormwater volume reduction. See Chapter 9 and Appendix J of this report for more information on stormwater BMP and green infrastructure uses and limitations.

Opportunities in Redeveloping Areas

Stormwater management and subsequent ordinance and standards adoption is relatively "new" starting in the 1970s compared to the establishment of communities dating back to the 1700s and 1800s. Of the 117 respondents to the survey (Appendix B), 39 (33%) stated that their community has combined sewers. Structures built between 1950 and 1969, while less than 30% of the total building stock in urban areas, account for more than 40% of private claims and more than 50% of NFIP claims (see Figure 3.1). These structures precede the common usage of stormwater design standards before the establishment of the NFIP. Communities have the opportunity to revitalize and update the stormwater infrastructure as well as mitigate open space and floodplain area losses as areas redevelop.

Recommendations

1. The State should fund the Illinois State Water Survey to update the existing rainfall frequency distribution information using the additional rainfall gauge data that are available with routine updates every 15 years. Future precipitation projections and also future land use should be included where it is available. When planning stormwater infrastructure modifications and enhancements, local governments should take into consideration these future precipitation trends and land use information.
2. Data collection is vital to all flood studies, project design and project operation; therefore, the Illinois General Assembly should continue to provide cost share funding to allow for the following:
    a. maintenance and expansion of the USGS stream and rain gage network by the Illinois Department of Natural Resources,
    b. continued monitoring of climate and flood data by the Illinois State Water Survey to better validate and fine tune the present climate projections and their effects on urban flooding; and
    c. continued monitoring of progress in climate model developments and new scientific approaches to account for climate and other uncertainties.
3. Communities should establish overland stormwater conveyance areas in all new development areas, and these flow paths should be maintained and regulated.
4. Communities should improve stormwater management in redeveloping areas by adopting stormwater ordinances that incentivize reduction of imperviousness and updating storm water systems, especially in known flood problem areas.
5. Communities should consider adoption of ordinances to address drainage for below-grade construction, such as requiring sewers to exit structures within 2 to 3 feet of the finished exterior grade of buildings. Adoption of International Building Code Sections R405 and R406 for foundation drainage and waterproofing should also be considered.

Chapter 6: Consistency of Criteria for State Funding of Flood Control Projects

Key Findings

- The distinct programs offered by the Illinois Department of Natural Resources (IDNR), the Illinois Emergency Management Agency (IEMA), the Illinois Department of Commerce and Economic Development (DCEO), and the Illinois Environmental Protection Agency (IEPA) each have their own funding sources and unique criteria for specific types of flood control.
- The IDNR has the only fully state-funded flood control program. The funding requirements for the federal matching fund programs are not controlled by the state.
- There is no state funding program that addresses individual basement mitigation because currently the State cannot spend State dollars on private property for private gain.
- Except for the IDNR program, prior planning is the key to funding speed. Fund disbursement is contingent on planning being complete.
- National Flood Insurance Program (NFIP) participation is required for all of the programs except for the DCEO program.

There are only a few criteria that are consistent between the agencies for eligibility requirements for different sources of funding as shown in Figure 6.1. One is that the local government requesting the project funding must participate in the NFIP to qualify for most of the programs (see Chapter 7 for more information about the NFIP). NFIP participation allows property to be protected from flooding damage that would otherwise be borne through these public funding programs again. Prior approved planning is another criterion that is required by most of the programs. Table 6.1 lists the different state programs and some of their specific criteria. The federal government also provides funds, or cost shares, for flood control projects in Illinois through many of these agencies.

Funding Sources, Criteria and Process

IDNR

The Office of Water Resources (OWR) has the only fully state-funded flood control program. OWR's Urban Flood Control program has been implemented for many decades under the authority of the Flood Control Act of 1945. Historically, the OWR has chosen to limit its participation to problems caused by out-of-bank riverine projects; OWR will develop and construct projects that provide an outlet for stormwater systems but has not participated in the development or construction of stormwater improvements.

Urban Flood Control Program: Local government requests for assistance to a severe flood problem are addressed through a study process as shown in Figure 6.1. If the initial feasibility is determined to be positive (out-of-bank flooding; likelihood of developing a feasible project) then a Strategic Planning Study is initiated. The Strategic Planning Study can take twelve months or longer to complete and are performed in-house, by consultants or by cost sharing/coordination with other governmental agencies or entities. The Flood Control Act of 1945 generally requires a favorable Benefit to Cost Ratio (B/C ratio equal or greater than 1.0) to proceed further.

Table 6.1: State funding programs and requirements

	IDNR/OWR UFC	IEMA FMA	IEMA PDM	IEMA HMGP	Direct Legislative Action	DCEO CDAP PI and Emergency PI	DCEO CDAP PI + Design	IEPA Revolving Loan
Types of Projects / Outcomes								
Storm Sewer Improvements		X	X	X	X	X	X	X
Combined Sewer Improvements					X	X	X	X
Conveyance Improvements	X	X	X	X	X			X
Levees	X				X			
Detention Basins	X	X	X	X	X			Potentially
Projects on Private Property		X	X	X				Potentially
Individual Basement Mitigation								
Repetitive Loss Structure Buyouts		X	X	X				
Planning Reports	X	X	X	X	X			Potentially
Program Outputs								
Project Specific Planning Documents	X				X		X	Potentially
Construction Documents	X				X	X	X	X
Construction Funding	X	X	X	X	X	X	X	X
Construction Engineering	X				X	X	X	X
Local Participation Requirements								
Operation and Maintenance	X	X	X	X	X	X	X	X
Utility Relocations	X							
Land Rights Acquisition	X							X
NFIP Participation	X	X	X	X		X	X	X
Emphasis on Low to Moderate Income						X	X	
Pre-Approved Planning		Mitigaiton Plan	Mitigaiton Plan	Mitigaiton Plan		X		
Program Funding								
Federal Disaster Declaration Required				X				
Local Cost Share		25%	25%	25%		25%	25%	Low interest loan
B/C Ratio	1.0 or greater	1.0 or greater	1.0 or greater	1.0 or greater	None	None	None	None
Funding Limits						$450,000 or $200,000 for Emergency	$450,000 max with $150,000 design included	None

UFC = Urban Flood Control, FMA = Flood Mitigation Assistance, PDM = Pre-Disaster Mitigation, HMGP = Hazard Mitigation Grant Program, CDAP= Community Development Assistance Program

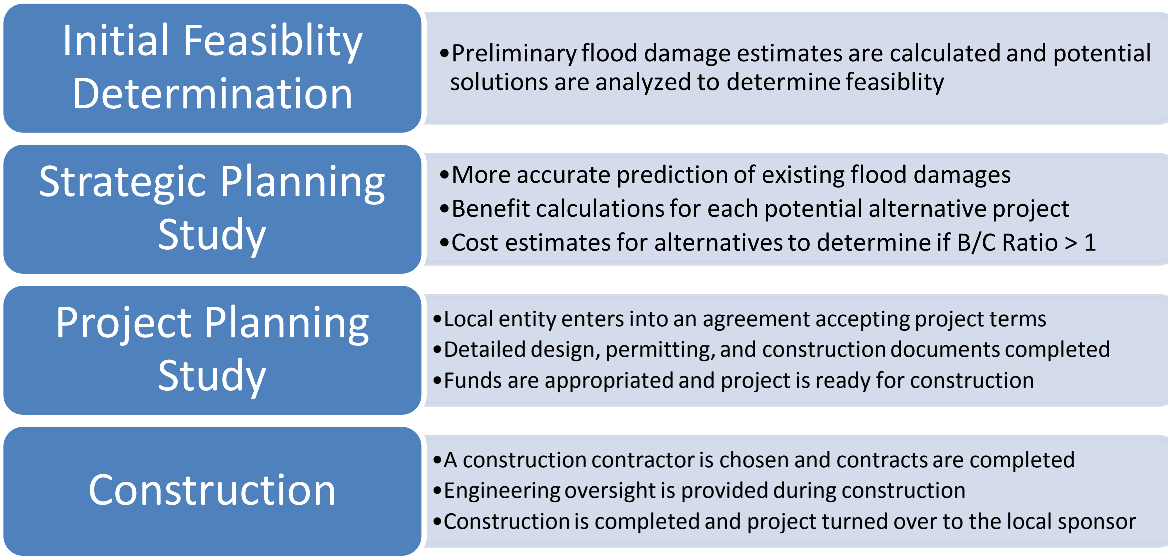


Figure 6.1: OWR's Urban Flood Control Program Process

The general requirements of a local sponsor are listed in Table 6.1. If the local entity requesting assistance is willing to be a local sponsor for a selected alternative, a Project Planning Study is initiated. Project Planning Studies are more detailed engineering design studies that are only performed for projects scheduled to be constructed as OWR projects. Funding for these projects is appropriated to OWR from the General Assembly; the funds are usually from the sale of capital project bonds so the money can only be used for activity that directly leads to a project that has a physical life of 15 years or more.

IEMA

IEMA administers the Hazard Mitigation Assistance program for the Federal Emergency Management Agency (FEMA) in Illinois. This includes a flood mitigation assistance program, an all hazards pre-disaster mitigation program, and an all hazards grant program related to federal disaster declarations. The goal of these programs is to reduce the risk of loss of life and property due to natural hazards. All of these programs are competitive, require NFIP participation, and are 75% federally funded. In order for local governments to receive funding through these programs, they must apply through FEMA's web-based application system. All of the programs also require a mitigation plan for the type of hazard that is being mitigated. IEMA takes all of the applications and determines which projects get funded by analyzing which projects align best with the programs goals. Funding disbursement can take from 1.5 to 2 years for completion of all paperwork and analysis. If local governments are proactive and complete mitigation planning before a disaster, then funding will be available for rebuilding after a disaster instead of just planning. Details about what the programs will cover are listed in Table 6.1.

Flood Mitigation Assistance Program: The goals of the Flood Mitigation Assistance (FMA) are to reduce the long-term risk of flood damage and the number of repetitively damaged structures, to encourage long-term comprehensive mitigation planning, and to respond to the needs of communities in the NFIP. The FMA is a cost-share program through which communities can receive grants for the development of a comprehensive flood mitigation plan that is needed to receive grants for the implementation of flood mitigation projects through the FMA. The funds allocated to the state are based on the number of flood insurance policies in place statewide as well as the number of identified repetitive-loss properties. Typically-funded FMA projects are for the acquisition and demolition of repetitively flooded structures in the floodplain insured by the NFIP.

Pre-Disaster Mitigation Program: The Pre-Disaster Mitigation (PDM) program makes funding available to local and state governments to implement cost-effective hazard mitigation activities that complement a comprehensive mitigation program. Funding may be awarded for development of an all-hazards mitigation plan or for a cost-effective hazard mitigation project. Local governments must have an approved local mitigation plan. The applicant is responsible for 25% cost share. In-kind services may be used, but no other federal source of money may be used to fund the local share. They must also participate in and be in good standing with the NFIP if a Special Flood Hazard Area has been identified (see Chapter 8 for Special Flood Hazard Area information).

Hazard Mitigation Grant Program: The Hazard Mitigation Grant Program (HMGP) makes grants available to state and local governments as well as to eligible private, non-profit organizations to implement cost-effective and long-term mitigation measures following a major disaster declaration. The amount of funding made available is a percentage of total disaster costs and therefore will vary with each disaster, but a project does not have to be in a declared county to be eligible. Communities must have an approved all-hazards mitigation plan. The applicants are responsible for a 25% cost share. They must also participate in, and be in good standing with, the NFIP. Projects can protect either public or private property but must be environmentally sound, cost effective, solve a problem and prevent future disaster damages.

DCEO

DCEO has no specific flood control authority. They are able to fund storm sewer projects through the public infrastructure section of their Community Development Assistance Program.

Illinois Community Development Assistance Program: The Federal Community Development Block Grant: Small Cities program that DCEO is administering as the Illinois Community Development Assistance Program is designed to assist Illinois communities in meeting their greatest economic and community development needs, with an emphasis on helping communities with substantial low to moderate-income populations. The public infrastructure component of the program is used to eliminate conditions detrimental to public health, safety and public welfare in primarily residential areas. Local governments are able to request grants of up to $450,000 for public storm sewer projects. If they cannot afford to design the project, up to $150,000 may be taken out of the grant for design services. This program has a once a year deadline dictated by HUD when all applications are due. The applications are ranked based 50% on readiness to proceed, 25% on threat or need, and 25% on low to moderate-income population score, and the disbursement of funds occurs approximately six months later. None of the construction may take place until all approvals are in place, and they have two years to complete the project from the disbursal of funds. In an emergency, communities may also apply for grant funds of up to $200,000 to undertake emergency storm sewer projects that have occurred in the last 18 months. If their preliminary application is approved, then they are asked to turn in a full application, and the emergency project funds can be awarded in less than two months.

IEPA

Revolving Loan Program: IEPA gives out loans, through their revolving loan program, for flood relief if the projects are tied to water quality improvements. This program provides loans for projects constructed in a combined sewer service area intended to reduce or eliminate street, area and basement flooding. Combined sewer service projects include the construction of relief combined sewers and the renovation, repair or replacement of existing combined sewers. The required IEPA-approved plan must provide the drainage area, in acres, that are affected by the proposed project, the annual number of street and/or area flooding occurrences, the frequency and number of basements affected by flooding and the number of basements in the drainage area. Projects that meet the above criteria and are approved would be loaned project money at half the Bond Market Interest Rate for a twenty year repayment schedule. When loans are repaid, the fund is replenished and other loans can be disbursed.

Federal

The Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act is a federal act that gives the State of Illinois specific opportunities for funding from the federal government. The governor may request a Federal Disaster Declaration for flooding that would give a number of flood relief options to the citizens in the declared areas. One caveat for disaster funding is that no one can receive future assistance if they have previously received assistance and their required insurance was not maintained (i.e. flood insurance).

Federal assistance can be received for state or local government facility repair or for private critical facilities to reduce or prevent future damage. Public facilities may include flood control, navigation, water supply and distribution, watershed development or non-federal roads and parks. The state is allowed to be self-insured for state-owned buildings, but no federal assistance will be given if insurance would have covered the loss.

Issues for Local Governments

Some of the issues local governments deal with when looking for funding for flood control programs is the lack of programs that deal with individual basement flooding, the longer timeframe for receiving funding, difficulties in securing local cost share funding, and the sometimes confusing application processes.

The timeframe for disbursement of funds to local governments through each of these programs varies depending upon the program and the agency staffing level. All except the IDNR program require prior planning before fund distribution to ensure that the allocation is spent on eligible projects that have all the necessary elements to ensure success. All projects must complete engineering planning, obtain necessary state and federal permits, obtain land rights, create the construction bid documents, and choose a contractor before construction may begin. All of these requirements add to the public's perceived timeframe after a flood. The general planning that must be completed for the federal cost-share programs can be completed by local governments before a flood to speed up the post-flood timeframe.

There is a lack of funding for state programs that deal directly with basement flooding, primarily due to the fact that only IEMA programs may spend state dollars on private property. Local governments are successfully using overhead sewer conversion programs with local funding to cost share with homeowners to raise the elevation of basement sewer connections in order to reduce sewer backup (see Appendix J). Many local governments also have trouble budgeting for cost share dollars and other program participation requirements that are mandatory for many of the existing state programs.

The application process for flood control funds is sometimes confusing for local governments that are not used to applying for funding through these sources. All of the agencies work with applicants to help move their applications forward but after a large flood, these offices deal with a considerable number of applications. If communities have not planned ahead, the process can be time consuming. One of the best strategies that local governments can utilize to expedite funding approval is to be proactive about mitigation planning. The programs that fund the mitigation planning process are available even when there are no disasters. Pre-planning would give communities the opportunity to fully assess their needs and to communicate their plans to local stakeholders when there are no deadlines for vital funding. Planning will also help local governments conceptualize the potential flooding problems and make it easier to convey those issues to the public.

The Illinois Statewide Resiliency Team

The Illinois Statewide Resiliency Team consists of the IDNR, IEMA, DCEO, and the Illinois Historic Preservation Agency. In response to the Housing and Urban Development (HUD) National Disaster Resiliency competition, the State is coordinating the expansion of this group to include Illinois Department of Transportation (IDOT), Illinois State Water Survey, Illinois Department of Agriculture, Illinois Department on Aging, Illinois Capital Development Board, Illinois Commerce Commission, Illinois Economic Recovery Commission, Governor's Office, Lt. Governor's Office, Illinois Housing Development Authority, Illinois Department of Insurance, Illinois Department of Public Health and the Illinois State Toll Highway Authority. The purpose of this state agency team will be to:

- Encourage resiliency in all state-funded capital projects;
- Promote interagency communication and multi-purpose benefits across state agency programs in ongoing and future state funded community projects;
- Orchestrate resources to help communities plan and implement disaster recovery and preparedness that makes them more resilient to future threats while improving quality of life; and
- Leverage multi-agency funding; for example, a small community slated for an IDOT highway by-pass around town requiring extensive borrow and/or roadway embankment fill could utilize such work to also provide additional flood storage created by the borrow site and/or embankment.

Recommendations

1. The Illinois General Assembly should continue (and increase) its funding of flood hazard mitigation programs to allow state agencies to better leverage federal mitigation funds.
2. The State should provide grants or revolving loan opportunities to communities to support implementation of local cost sharing mitigation programs for residents impacted by urban flooding, to evaluate stormwater system capacity and flood risk, and to encourage stormwater management planning.
3. Local and county governments should be required to participate in the NFIP as a prerequisite for state funding and grant assistance for flood damage reduction-related activities.
4. The authorities for justification of state capital projects are currently inconsistent making it more difficult to seek funding from one state agency versus another for similar flood damage reduction purposes. Funding criteria should be made consistent across all state agencies.
5. To better utilize funding that is available through Illinois Emergency Management Agency for mitigation projects, communities are encouraged to complete pre-disaster planning.
6. The Illinois Mitigation Advisory Group should expand their mission with representatives from various state agencies to coordinate grant programs and projects to ensure consistent funding requirements, leverage state funding efficiencies, promote resiliency, and avoid project overlap. This group should identify and prioritize urban drainage flood mitigation planning in Illinois so existing mitigation actions can occur quickly and efficiently as funds become available.

Section 3
Strategies for Reducing Urban Flood Damages

There is no single solution for reducing the damages experienced due to urban flooding. However, there are multiple strategies that can be adopted to deal with root causes, enhance public awareness and understanding of insurance options, and encourage communities and individuals to take action to reduce losses and avoid increasing flood damages in the future. This section examines the options individuals have to transfer their risk of flooding through the purchase of homeowners insurance offered by private insurers and flood insurance available through the National Flood Insurance Program. The long-term strategy for truly reducing flood damages is to mitigate flooding for individual structures and for communities to take action by adopting policies and programs that alleviate the source of flooding.

The Normal, IL roundabout project combines green and gray infrastructure to provide an appealing community focal point with stormwater management. Photo credit: Scott Shigley

Chapter 7: Strategies and Practices to Increase the Availability, Affordability and Effectiveness of Flood Insurance and Basement Back-up Insurance

As evident with urban flooding, a home or business does not have to be in a high-risk flood area or be where major flooding has previously occurred to be damaged by water. However, a common misperception is that a typical homeowners or commercial insurance policy will cover the damage. Unfortunately, in most cases that is not true. A typical policy excludes damage caused by water from three sources: 1) flooding (e.g., rising water), 2) sewer or drain back-up or overflow from a sump, and 3) seepage through a structure.

To help provide additional financial protection, a separate flood insurance policy can be purchased through the National Flood Insurance Program (NFIP) or a private insurance company to cover the first exclusion and an endorsement ("Water Back-up") can be added to a homeowners or commercial policy for the second exclusion. With flooding being the number one disaster in the U.S. and purportedly 60% of homes possibly experiencing a wet basement at some time, these are two important coverages for a property owner to consider. This chapter will look into each of these coverages.

Key Findings

- Coverage for damage due to water/sewer back-up is readily available as an endorsement to an existing residential or commercial policy, and available as a separate policy through the NFIP or private carriers for damage due to flooding.
- Water/sewer back-up average annual costs range from $30-$300 for $5,000-$50,000 in coverage and can be financed.
- NFIP maximum coverage for 1-4 family residential building and contents is $250,000/$100,000; it is $500,000/$500,000 for non-residential coverage. There is limited coverage in basements in an NFIP policy.
- Flood insurance premiums can be quite low for properties in moderate-low risk areas but can be very expensive, especially for secondary homes and businesses in high-risk areas which were built before the community's first flood map became effective and/or if the first floor was built too low.
- Significant rate increases due to FEMA implementing reform bills passed by the U.S. Congress has created an affordability issue as well as a possible cause for significant drop in policy count.
- With an NFIP policy's total premium due at policy inception or by renewal, the ability for low- and fixed-income policyholders to pay can be quite challenging. Academia, associations and others have weighed in with affordability recommendations ranging from means-tested voucher programs, to property mitigation efforts supported by grants, loans, tax credits and rebate programs, to adopting and enforcing higher building standards.
- The insurance industry and state and local communities can work better together to increase residents' and business owners' awareness of coverages available, enhance education about their risk and work with them on ways to reduce the risk and their cost for insurance.

Availability and Effectiveness of Basement Back-up and Flood Insurance

Basement Back-up Insurance ("Water/Sewer Back-up")

The basement of any home or business can experience water/sewer back-up, seepage or flooding. And in most cases, the typical homeowners and commercial insurance policy will not cover the resulting damage. If the basement water is due to a flood, including a flood causing water to back up through drains in the basement, a separate flood insurance policy would provide limited coverage. If it is due to other conditions, including the failure of a sump pump, a low-cost endorsement could help cover the costs.

Other than an effect directly due to flooding, water/sewer back-up in basements can be a result of different causes including blockage from tree and shrub roots on or adjacent to the building owner's property and blockage in the community's adjoining sanitary or storm sewer line. Overwhelmed community stormwater drains from heavy rains could also result in a back-up. These back-ups could come through toilets, showers, washtubs, and sump pumps in a basement. Wet basements can also occur from water seeping into very small cracks after repeated heavy rains and a very saturated soil. In fact, as a building ages, the chance of seepage could actually increase through resulting small cracks and the basement floor and walls becoming less waterproof. Finally, the failure of a sump pump in the basement could result in the basement flooding.

While there is no requirement for insurance companies or agents to offer coverage, most homeowners insurance companies offer an optional water/sewer back-up and sump overflow endorsement, which can be added to the policy to cover this damage. A standard wording that many companies use (or a variant thereof) is the Insurance Services Offices (ISO's) endorsement (HO 04 95 01 14), which is filed with the Illinois Department of Insurance. The endorsement states that coverage will be up to the limit selected to cover direct physical loss caused by water which backs up through a sewer or drain or water that overflows or is discharged from a sump pump, even if it is a result of the sump pump not working. It does not cover the cost for mechanical breakdown of the pump, nor does it cover back-up due to flooding or for seepage through cracks in the wall or floor. Coverage limits can range from $5,000 to $50,000 with deductibles from $500 to $5,000, with the typical limit being $5,000 based on conversations with insurance carriers. Typically, any claim related to the building would be paid at replacement cost, and even possibly on the contents as well (as opposed to Actual Cash Value, which is the depreciated value). This, of course, varies by insurance company as does the number of times a company will pay such a claim before cancelling the policy. Taking into account the fear of potential cancellation for reporting a loss or too many losses, the actual of number of losses may be higher.

Each insurance company files their own rates, and costs can vary based upon location plus the limit and deductible chosen (e.g., $500 deductible for $5,000; $5,000 for $50,000). Some insurance companies in Illinois have also divided the state into zones based upon location. As a result, a premium for $5,000 might run from a low of $30 to a high of $125 depending on location and up to $300 for $50,000 in coverage. This endorsement's premium would be included with the total policy premium, which in many cases can then be financed (e.g., monthly, quarterly payments) with the insurance company or through the insurance agency, thus making it easier to pay and afford.

Flood Insurance[1]

While an endorsement to a homeowners or commercial policy could provide some coverage for basement flooding due to water/sewer back up, these policies typically do not cover damage due to flooding. However, a separate flood insurance policy through the NFIP is available to all Illinois renters, homeowners and business owners located in one of the 877 communities that participate in the NFIP (about 87% of all Illinois communities). It is sold by insurance agents who represent the NFIP directly or one of about 85 companies that have agreed to write the NFIP policy under their company name. Residential limits of coverage are available up to $250,000 for 1-4 family buildings and $100,000 for the contents; non-residential limits are $500,000 for the structure and $500,000 for contents. While the typical homeowners' policy provides for replacement cost for damages to the building and may also be available for the contents, replacement cost is only available for principal residences that are insured to at least 80% of their Replacement Cost Value (and residential condominium associations). Claims on contents and on non-principal residences and non-residential buildings are paid at Actual Cash Value (depreciated value). There are also some flood insurance programs through private carriers that provide similar coverage as the NFIP, many of which are written through Lloyds of London syndicates; additional coverage above the NFIP limits is also available through certain private insurance companies and Lloyds of London.[2] While a disaster needs to be presidentially-declared to receive federal disaster assistance, flood insurance is available even if the flooding is very local and there is no declaration, as long as it meets the definition of a flood. As opposed to a homeowners or commercial policy, an NFIP flood insurance policy cannot be cancelled or non-renewed due to too many claims.

The NFIP definition of a flood is very specific (see Appendix I), but basically just two or more properties need to be partially or completely inundated by the overflow of inland or tidal waters. So, if sewer backup occurs in the basement because of flooding, it is covered; otherwise, damages due to sewer backup are not covered by this policy. And like most policies, there are limitations and exclusions. For example, this policy has limited coverage in basements[3]. If a claim occurs on an NFIP policy, building coverage in the basement is limited to just basic structural items in the basement (e.g., foundation walls, staircases, drywall) and items to help "run" the building (e.g., circuit box, central air conditioning, furnace, water heater, sump pump); and if contents coverage is purchased, it will include washers, dryers and food freezers (not refrigerators). However, the policy will not cover items like paneling, bookcases, carpeting or tile, and most contents including items like TVs, sound systems, furniture, rugs and clothing. In other words, finished basements have limited coverage.

[1] A more detailed discussion about the NFIP's flood insurance program is provided in Appendix I.
[2] A listing of example primary, excess and force-placed flood insurance programs is provided in Appendix I.
[3] The NFIP policy defines a basement as any area of the building having its floor subgrade (below ground level) on all sides.

While the NFIP policy is available to residents and business owners in 87% of Illinois' communities, a very low percentage – when compared to the number of households – have this separate policy, even in high-risk areas (e.g., flood Zone A, AE) where flood insurance is to be required on all mortgages through federally insured and regulated lenders. A national study by RAND Corporation in 2006 showed that about 25% of property owners in a high-risk area with a mortgage did not have flood insurance and there was probably another 25% that did not have a loan and also had not purchased coverage. One reason some property owners do not choose to buy coverage is due to the limited amount of coverage provided for basements compared to what they have in their basement (e.g., fully furnished family room, bedroom, bathroom). Another main reason is many feel they are not at risk and therefore, it is not worth the cost. The NFIP policy count has dropped significantly since the implementation of significant rate increases in October 2013 as required by recent flood insurance legislation (discussed in the next section), with both nationally and in Illinois, losing about 5.6% of the policies-in-force (-310,000 policies and -2,800 policies, respectively).

Flood Insurance Cost

The majority of property owners in Illinois live in moderate-low risk areas (e.g., Zone X) and would qualify for the NFIP's lower-cost Preferred Risk Policy (PRP), with premiums starting as low as $162 for a primary residence ($20,000 in building and $8,000 in contents coverage). About 38% of the 47,105 NFIP policies in force in Illinois are written in moderate-low risk areas. Overall, since 1978, 20% of flood claims in Illinois come from policies in these moderate-low risk areas[4].

Flood insurance for properties in the mapped high-risk areas is typically more expensive. Premiums vary depending upon many factors but two major ones are:

1. the difference between the building's Lowest Floor Elevation (LFE) and where the flood waters are projected to rise to (known as the Base Flood Elevation or BFE), and
2. if the building was built before the first Flood Insurance Rate Map (pre-FIRM) or after (post-FIRM).

Most post-FIRM buildings in high-risk areas are elevation-rated and require an Elevation Certificate. The higher the LFE is above the BFE, the lower the premium (up to 4 feet above BFE). Conversely, the lower the LFE (which could be the basement floor for buildings with basements) is below the BFE, the premium becomes significantly higher (see Table 7.1). In Illinois, most communities strictly enforce floodplain regulations on new development in the floodplain (post-FIRM construction) and buildings are built with the lowest floor (including any basement) at or above the BFE.

Since pre-FIRM buildings were constructed before a community's first FIRM and there were no building regulations tied to a flood map, a building's lowest floor (e.g., basement) could very easily be below the current BFE. If that building was elevation-rated today like a post-FIRM building, the flood insurance premium would be quite high; however, when creating the NFIP in 1968, Congress allowed owners of pre-FIRM buildings to receive subsidized rates of 40-50% of the true rate. While Congress may have felt that over time the number of these buildings would decline to an insignificant number, as of 2013, close

[4] Nationally, 25% of the claims and about one-third of federal disaster claims are from moderate-low risk areas.

to 20% of the NFIP policies were on pre-FIRM buildings in high-risk areas, with that number being well over 50% in Illinois.

NFIP reform legislation passed by Congress in 2012 and 2014[5] had a focus on creating a more financially stable NFIP with one of its goals being the eventual removal of all subsidized rates. Consequently, implementation of the legislation has had an impact on premiums, especially pre-FIRM businesses and pre-FIRM non-primary residences as their rates increase 25% annually until they reach full-risk rate (i.e., elevation-rated) [6]. Even pre-FIRM primary residence rates are expected to increase each year by about 15% (a cap that HFIAA placed on annual rate increases). The long-term financial impact on a homeowner and business owner could be quite substantial.[7]

Table 7.1: Comparison of premiums ($200,000 residence on slab; $80,000 contents; Zone AE; April 2015 rates)

Difference Between Lowest Floor and Base Flood Elevations	Annual Elevation-rated Post-FIRM Premium (without HFIAA Surcharge)	Annual Pre-FIRM Premium (without HFIAA Surcharge)
+4'	$528	$3,296
+3'	$561	$3,296
+2'	$649	$3,296
+1'	$921	$3,296
0'	**$1,874**	**$3,296**
-1'	$4,376	$3,296
-2'	$6,371	$3,296
-3'	$8,316	$3,296

Strategies for Increasing Affordability of NFIP Flood Insurance

With the passage of the two reform bills, the cost of flood insurance for many has and will increase significantly both in Illinois and nationwide. As a result, affordability has become more of an issue, especially for the low or fixed income households, especially since the NFIP requires 100% of the annual premium paid at inception and by each subsequent renewal date (i.e., no premium payment plan). While Congress has asked FEMA to study methods to make flood insurance more affordable (the first of two reports was released March 2015), recommendations have already come from academia, associations and the Federal Government (Government Accountability Office). These have included:

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[5] Biggert-Waters Flood Insurance Reform Act of 2012 (Biggert-Waters); Homeowner Flood Insurance Affordability Act of 2014 (HFIAA)

[6] Included in HFIAA was a new HFIAA surcharge for all policies to financially balance out the new longer path pre-FIRM buildings would take to reach full-risk rates. An annual HFIAA surcharge of $25 for primary residences and $250 for all other buildings will be applied to all policies until all subsidized rates are eliminated. While this results in an additional financial burden to pre-FIRM secondary homes and business in high-risk areas whose rates are doubling every four years under the new legislation, there is also concern that those who voluntarily purchased flood insurance in the moderate-low risk areas (i.e., PRP) may drop their policy entirely.

[7] Using the example premiums in Table 1, a pre-FIRM primary residence's premium with a -3-foot difference in elevation has an equivalent full-risk (elevation-rated) premium today of $8,316. If the full-risk premium increases at 10% annually (for example) and the current pre-FIRM premium increases at 15% annually, the policy will finally reach the equivalent full-risk premium of about $61,500 in 21 years.

1. Create a voucher program that is independent of FEMA, funded by taxpayers, and based upon need; i.e., means-tested, like U.S. Department of Housing and Urban Development's (HUD's) Housing Choice Voucher program
2. Lower insurance premiums through mitigation efforts; e.g., elevate, install proper flood openings in enclosures, relocate the building. Sources of funding for these efforts potentially include: Small Business Administration Disaster loans, NFIP policy's Increased Cost of Compliance (ICC) coverage, FEMA's Hazard Mitigation Assistance Grant Program, HUD's Community Development Block Grants, and possible state tax credits for approved mitigation efforts
3. In-tandem use of vouchers and loans for mitigation efforts to more quickly and cost-effectively reduce risk and the cost of insurance
4. Provide a community-based rebate program for qualifying mitigation projects,
    a. Many Illinois communities offer a maximum $2,500 rebate for approved projects
5. Provide state-established low interest mitigation loans
    a. The State of Connecticut offers low-interest loans to coastal homeowners and small business up to $300,000 in their *Shore-Up Connecticut* program.
6. Adopt state floodplain regulations which require additional height above the BFE for new and substantially damaged/improved buildings. This not only reduces the risk and the rate, but communities participating in the Community Rating System (CRS) program (see Chapter 8 for additional CRS discussion) get credits, which could ultimately increase the discount policyholders receive.
7. Promote CRS more strongly, not only to existing communities to improve their class ranking and to communities in the CRS program.
    a. Currently, the highest discount offered to policyholders in high-risk areas in Illinois is 25%; the highest possible is 45%
8. Promote the use of HUD's FHA 203K Loan for mitigation projects. The Section 203(k) Program is the primary program for the repair and rehabilitation of single family properties and can be used for mitigation projects as long as the structure is not demolished.
9. Set up insurance policy funded state insurance pools for flood mitigation or catastrophic losses

Strategies for Increasing Awareness of Water/Sewer Back-Up and Flood Insurance

Flood insurance and water/sewer back-up insurance is readily available in Illinois. For less than $100 a year, homeowners can get some financial protection for water/sewer back-up damages and less than $200 a year get some coverage for flood damages (in moderate-low risk areas). The challenge is educating residents and business owners not only about the risk and the consequences, but what their options are to reduce the risk (and the cost). FEMA has a national marketing campaign (FloodSmart) that helps educate the property owner about their flood risk and the benefits of flood insurance. They also focus on educating the agents and other stakeholders (i.e., floodplain and stormwater managers) and providing them tools to help better communicate the risk of flooding. The State of Illinois could explore utilizing what FloodSmart does and modify the message to include urban flooding. The state could also launch an Illinois Flood Awareness week in conjunction with the National Flood Awareness Week (typically in March) to promote not only the awareness of the risk of flooding, but also the availability of these coverages.

At the local level, while an insurance agent should always offer their clients flood insurance and water/sewer back-up coverage to those with basements, there is no state or federal requirement to do so. To increase awareness of the availability and importance of these two coverages (and that the policy does not include either of these coverages), all insureds could be required by state law to sign a waiver that they did not want either coverage. In addition, an insert could be included in the policy mailing to highlight that the policy does not provide either of those coverages. While there are insurance companies and agents that do one or both of these, it is not universally done.

Research shows that a campaign is more successful when the intended audience hears the message from different sources. Increasing awareness of the risk of urban flooding is no different; it's a shared responsibility.

Recommendations

1. The Illinois General Assembly should allow the Illinois Department of Insurance to mandate continuing education specific to flood insurance for insurance agents.
2. The Illinois General Assembly should fund a state agency to develop an awareness campaign about the risks associated with urban flooding and options available for flood reduction and recovery. An educational flyer should be developed to provide to home buyers at closing. This flyer should provide basic information and resources on flood insurance, sewer backup insurance, flood mitigation, and available programs. Another flyer should be developed to inform renters of insurance coverages available to them. Education and outreach could also include a Flood Awareness week in conjunction with the National Flood Awareness Week.
3. The Illinois General Assembly should fund research to determine if lower income households have adequate private basement backup and flood insurance as they appear to have fewer private insurance claims than higher income households. If affordability is an issue with private basement coverage or flood insurance, incentive programs and insurance pools used by other states should be investigated.
4. Illinois' congressional delegation should encourage FEMA to consider state-based flood insurance underwriting to more accurately reflect flood loss history in Illinois and establish actuarial premiums within Illinois.
5. The Illinois Department of Natural Resources and Illinois Environmental Protection Agency should collaborate to appropriately expend portions of the state revolving fund for implementation of stormwater management measures.

Chapter 8: Strategies for Increasing Participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS)

Key Findings

- Nearly 87% of Illinois communities participate in the Federal Emergency Management Agency's National Flood Insurance Program (NFIP), or 877 communities. This is one of the highest levels of NFIP participation in the nation.
- Fifty-nine Illinois communities participate in the NFIP's voluntary Community Rating System (CRS) program and property owners in those communities receive flood insurance premium discounts. More Illinois communities should participate in the CRS.
- Illinois communities are able to achieve better CRS classification compared to much of the country due to (1) state efforts to reduce flood damages, (2) countywide stormwater management efforts in regions of the state, and (3) individual community initiatives.

As discussed in the Chapter 7, the NFIP makes federally-backed flood insurance available to property owners and residents within participating counties and municipalities. The Community Rating System (CRS) is a program within the NFIP that offers flood insurance premium discounts to communities for flood damage reduction activities that go above or beyond the minimum requirements of the NFIP. The NFIP and the CRS are administered by FEMA in coordination with the NFIP State Coordinator within the Illinois Department of Natural Resources, Office of Water Resources (IDNR-OWR).

Special Flood Hazard Areas (SFHA) and Flood Zones

Each community in the NFIP is provided with a Flood Insurance Rate Map or FIRM that identifies flood risk and shows the Special Flood Hazard Area (SFHA). The SFHA is shown on the FIRM as the area where a 100-year flood is likely to occur. This does NOT mean a flood will occur only once every 100 years. Rather, there is a 1% chance that flooding can occur in any given year within the SFHA. A 1% annual chance flood can occur in consecutive years, or twice in ten years, and so on.

The SFHA is generally the "A Zone" and the rest of the community outside the SFHA is generally an "X Zone" since flooding and significant flood damage can occur elsewhere in the community. Flood insurance is available in all flood zones, and as discussed in Chapter 7, the purchase of flood insurance with a federally backed mortgage in A Zones (i.e., SFHA) is required.

National Flood Insurance Program (NFIP)

The NFIP provides flood insurance to property owners while also requiring certain flood damage reduction activities by communities. Both the insurance aspects and the regulatory requirements of the NFIP are efforts to reduce taxpayers' burden for recovery from flood damage to buildings and building contents. Appendix I provides information about the NFIP and how communities can join the program.

Through a community's participation in the NFIP, flood insurance coverage is made available to *all* property owners and residents throughout the community. The NFIP requires communities to adopt and enforce certain minimum floodplain regulations to reduce damage to buildings in the Special Flood Hazard Area (SFHA). One of the minimum requirements is the lowest floor elevation, including the basement or crawlspace, must be at or above the base flood elevation (BFE) for all new construction or substantial improvement of existing building with in the SFHA. The NFIP requirements can be found in Chapter 44 of the Code of Federal Regulations (44 CFR).

NFIP Participation in Illinois

Almost 87% of Illinois communities participate in the NFIP, or 877 communities. This is one of the highest levels of NFIP participation in the nation. An NFIP community means both counties and municipalities. All DuPage County municipalities participate in the NFIP. In other urban counties, all except one or three municipalities in each county participate in the NFIP.

Floods and Flood Damage

Flooding along rivers and streams, and around lakes, is natural. The floodplain is nature's designated area to store and convey flood waters in any season of the year. The flood damage that occurs within the SFHA is due to buildings and infrastructure being placed within the SFHA. Urbanization increases the amount of floodwater that rivers and streams must convey (and floodwater the SFHA must store) – and increases the frequency that floodwater conveyance and storage is needed.

The Community Rating System (CRS)

The NFIP's Community Rating System (CRS) was created in 1990 and has three goals:

- Reduce and avoid flood damage to insurable property,
- Strengthen and support the insurance aspects of the NFIP, and
- Foster comprehensive floodplain management.

The CRS is a voluntary program. NFIP-compliant communities may participate in the CRS provided they meet several prerequisites. The CRS credits communities who implement floodplain and watershed management programs that exceed the minimum requirements of the NFIP. Communities can also receive credit for state and/or county programs. The number of CRS credits determines a community's CRS class, and NFIP flood insurance premium rates are discounted based the CRS class. Table 8.1 shows the CRS classes and the premium discounts for buildings located in and outside the SFHA. Class 1 requires the most credit points and gives the greatest premium reduction or discount. NFIP communities who do not participate in the CRS are Class 10 communities. The CRS rates a community for its current flood damage reduction efforts, and also provides incentives (i.e., flood insurance premium discounts) for additional flood damage reduction activities at the community, county and state levels of government.

The CRS program is "revenue neutral." This means that flood insurance premium discounts given within one community are flood insurance premium increases in another community. In 2014, the total CRS premium discount across the nation was around $330 million. In simple terms, based on the number of flood insurance policies around the county, a CRS Class 8 community is the revenue-neutral level, and the flood insurance policy holders in Class 10 and Class 9 communities pay for the discounts provided to Class 7 through 1 communities. This means communities who implement higher regulatory standards than the NFIP minimums and perform other flood damage reduction activities should join the CRS to avoid paying for discounts in other communities across the nation.

Table 8.1: CRS Classes, Credit Points and Premium Discounts.

CRS Class	Credit Points	Premium Reduction	
		In SFHA	Outside SFHA*
1	4.500+	45%	10%
2	4,000–4,499	40%	10%
3	3,500–3,999	35%	10%
4	3,000–3,499	30%	10%
5	2,500–2,999	25%	10%
6	2,000–2,499	20%	10%
7	1,500–1,999	15%	5%
8	1,000–1,499	10%	5%
9	500–999	5%	5%
10	0–499	0	0
Preferred Risk Policies and minus-rated policies are not eligible for CRS premium discounts.			
Source: *CRS Coordinator's Manual*, FEMA, 2013			

CRS communities are provided points or credit for implementing any of 19 creditable activities, organized in the four categories of public information (300 Series), mapping and regulations (400 Series), flood damage reduction (500 Series), and flood warning and response (600 Series). Most credits are for a community's floodplain management efforts within the SFHA; however, communities are encourages and are credited for the management of other flood prone areas and watershed areas. Also, many activities apply to and benefit the entire community, such as public information, preserving open space, stormwater management regulations, and flood warning and response. Most of the strategies presented in Chapter 7 can be eligible for CRS credit within one or more of the CRS creditable activities.

The CRS program and the CRS activities are presented in the CRS Coordinator's Manual (Manual). The Manual includes formulas and adjustment factors used to calculate credit points for each activity. A list of the creditable activities is included in Appendix I, and credits for community efforts within and outside the SFHA are noted.

Current CRS Participation Illinois

As of May 2015, 59 Illinois communities participate in the CRS, or about 6% of Illinois' NFIP communities. Only five other states have more communities participating in CRS (Florida, California, North Carolina, New Jersey and Texas). Figure 8.1 shows the location of Illinois communities that participate in the CRS.

Figure 8.2 shows the CRS participation and the CRS classifications in the nation and in Illinois. Six percent is the national average for NFIP community participation in the CRS, yet within the 6% of NFIP communities is 67% of the NFIP insurance policy base. This means that the majority of communities with the highest risk of flood damage across the country participate in the CRS discount in order to receive flood insurance premium discounts. Illinois communities are able to achieve better CRS classification compared to much of the country due to (1) state efforts to reduce flood damages, (2) countywide stormwater management efforts in regions of the State, and (3) individual community initiatives.

While the CRS is a community-based and community-driven program, state activities and initiatives can translate into CRS credits for communities provided the activities are enforced within the community. Table I.6 in Appendix I shows the CRS credit opportunities for communities based on IDNR-OWR programs.

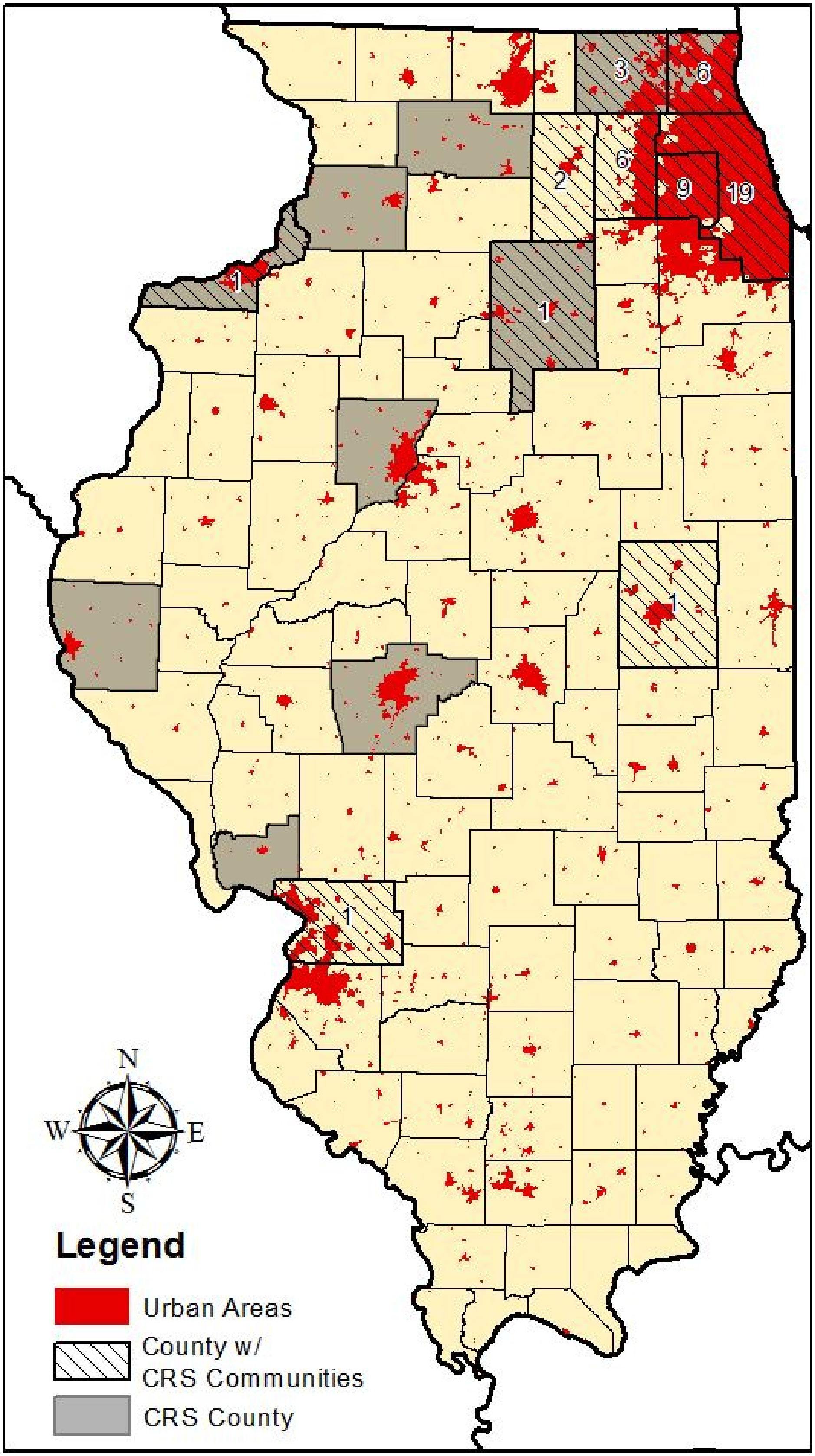
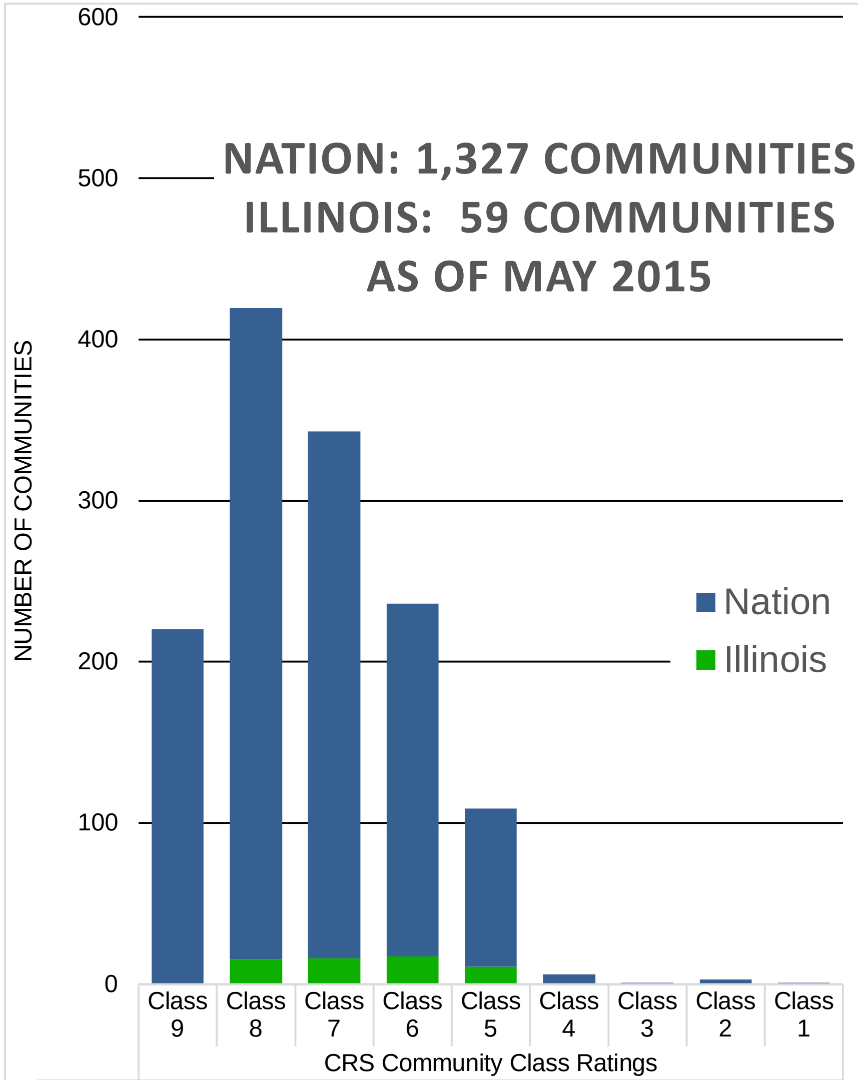


Figure 8.1: Location of Illinois communities that participate in the CRS.

Benefits of CRS Participation

Besides the benefit of reduced insurance rates, CRS floodplain and watershed management activities enhance public safety, reduce damages to property and public infrastructure, avoid economic disruption and losses, reduce human suffering, and protect the environment. CRS requires community staff time. However, when many of the CRS activities are already part of a community's ongoing services, the documentation and certification requirements can be incorporated into normal operating routines. CRS also helps to organize community incorporate flood damage reduction efforts into a comprehensive program.

While CRS credits focus on efforts within the SFHA, numerous activities benefit residents and property owners throughout the community. Community public information efforts (printed materials or websites) about floods and the potential for flood damage can reach the entire community. Protecting open space within the floodplain benefits everyone. Proper administration of building codes protects all buildings from flood damage. Effective flood warning and response programs reach floodplain residents, and also inform people that travel to work or school. More information on these activities, along with information on how a community applies for CRS participation is included in Appendix I.



	Class 9	Class 8	Class 7	Class 6	Class 5	Class 4	Class 3	Class 2	Class 1
Nation	220	472	327	219	98	6	1	3	1
Illinois	0	15	16	17	11	0	0	0	0

Figure 8.2: CRS participation and the CRS classes in the nation and in Illinois.

Table 8.2 provides a summary of flood insurance policies, the total annual premiums paid and the saving in premium rates achieved by Illinois' CRS communities. Over 13,000 flood insurance policy holders in Illinois benefit from the CRS. Over $1.9 million in flood insurance premium discounts or savings is provided to policy holders by Illinois community CRS participation.

Table 8.2: Policies, Premiums and CRS Savings for CRS Communities in Illinois.

Flood Insurance in Force	Flood Insurance Premiums Paid	CRS Total Premium Discount (or Savings)
13,090 Policies	$11,550,023	$1,909,075

Source: FEMA, as of May 2014

Strategies for Increasing NFIP and CRS Participation

Illinois community participation in the NFIP is very high. IDNR-OWR should continue to promote NFIP participation. No changes in IDNR-OWR current approach regarding NFIP participation is recommended in this report. IDNR-OWR and FEMA encourage community participation in the CRS with available staff and other resources. The following recommendations are aimed at improving Illinois community participation in CRS and for improving CRS classifications for current CRS communities.

Recommendations

1. Illinois' congressional delegation should encourage FEMA to allow Community Rating System (CRS) points for state flood damage reduction programs.
2. Illinois' congressional delegation should request that FEMA modify and expand their national CRS training to include Illinois-specific training.
3. Communities and counties participating in CRS should participate in the Illinois Association of Floodplain Managers (IAFSM) CRS users group.
4. Non-CRS municipalities should consider using CRS principles in stormwater management to make their communities more resilient.
5. The Illinois Department of Natural Resources should expand CRS resources to improve CRS outreach to communities as funding from FEMA is available.

Chapter 9: Strategies for Minimizing Damage to Property from Urban Flooding

This chapter provides information on strategies for minimizing damage to property from urban flooding, with a focus on rapid, low-cost approaches, such as non-structural and natural infrastructure, and methods for financing them.

The three most common types of urban flood damage reported in the survey of Illinois community officials (see Appendix B) are basement water seepage, basement sewer backup and water coming in through basement windows. Urban flooding is known to cause numerous public health and safety concerns, such as mold and sewage contamination in homes, and limited emergency vehicle access on city streets. Selecting appropriate strategies to reduce urban flood damages requires knowledge of the cause of the urban flooding.

Key Findings

- The three most common types of urban flood damage reported in the survey of Illinois community officials (see Appendix B) are basement water seepage, basement sewer backup and water coming in through basement windows.
- Strategies to mitigate the problems vary based on the local conditions. Thus, effective mitigation generally is implemented at the community, neighborhood, and/or property level.
- There are a number of flood damage reduction strategies that can be used to reduce damages experienced by property owners, including many that are low cost. Identification of the source of flooding is fundamental to successfully mitigating future damages.
- Education and outreach on identification of root causes is necessary to empower homeowners to solve flooding issues that can only be addressed on their property.
- Neither green nor gray infrastructure should be considered a single solution to urban flooding. Both complement each other while being subject to their own limitations.
- Development of a comprehensive stormwater management plan is a key component in reducing urban flood damage at a neighborhood or community scale.
- Illinois' Residential Real Property Disclosure Act provides a comprehensive list of material defects that must be disclosed when property is sold.
- A home rule municipality stormwater utility program assesses a fee to all those who benefit from the stormwater infrastructure and services provided. Dedicated stormwater program fees provide a stable, dedicated source of funding.

Green and Gray Infrastructure

Strategies to reduce urban flooding are often described as either gray or green infrastructure. Gray infrastructure is used to describe traditional engineering methods including storm sewers and detention ponds—built systems employed to collect runoff and discharge it quickly through the system. Green infrastructure is used to describe methods that utilize the natural functions of soil infiltration, evaporation and transpiration, emphasizing the reduction of rainfall runoff where it is produced. Green infrastructure techniques common in Illinois include rain gardens, downspout disconnection, bioswales, stormwater trees, permeable pavement, and green roofs.

Typical stormwater management systems are based on traditional gray infrastructure solutions, such as road gutters, storm sewers, and retention ponds. Most urban communities have design requirements for these systems (see Chapters 4 and 5). Stormwater infrastructure designed to modern standards most often performs acceptably for many years. Capital projects for replacement of gray infrastructure are costly and, due to funding constraints, many communities cannot prioritize addressing appropriate maintenance needs of these systems until they fail.

> "The City is working hard to improve our aging infrastructure, but there are 4,400 miles of sewer main in Chicago, and mere replacement is not the answer. The key is to keep as much water out of the sewer as possible during the heaviest rains."
>
> City of Chicago Basement Flooding Partnership website

Green infrastructure has several advantages over traditional gray infrastructure as well as its own limitations. Prompted by the Clean Water Act and the regulation of post-construction stormwater quality, communities are already looking to green infrastructure to achieve multi-objective benefits. In 2009, the Illinois Environmental Protection Agency (IEPA) submitted several recommendations concerning green infrastructure as required by Public Act 96-26, and reported that green infrastructure is effective in achieving stormwater quality goals as well as being cost-effective when compared to other methods (Jaffee, 2009). Recent green infrastructure pilot projects completed across the country continue to support the cost saving benefits of using green infrastructure (Copeland, 2014). Most green infrastructure projects will have some impact on reducing stormwater runoff and the result can be significant in some cases. Several green infrastructure resources are available via the IEPA. The primary limitation of green infrastructure for urban flood reduction is the dependence on soil conditions. Once the soil is saturated, the excess runoff may still need to be controlled by gray infrastructure to avoid flood damages. Successful use of green infrastructure relies on several site-specific parameters including drainage area, groundwater table levels, soil type, ground slope and performance of maintenance. Green infrastructure is often less costly, but when used in areas that are already urbanized, successful green infrastructure projects may still require engineering design. Green infrastructure will be most successful addressing urban flooding caused by more frequent lower volume rainfall events and should be part of a comprehensive plan to reduce volume entering over-taxed drainage systems (Schueler et al, 2007).

Neither green nor gray infrastructure should be considered a single solution to urban flooding. Gray infrastructure is costly and does not typically address the reduction of stormwater runoff volume. Green infrastructure has the ability to reduce runoff volume but due to the influence of location-specific parameters, its potential to reduce urban flooding damages is difficult to evaluate on a large scale.

Single Property Flood Reduction Strategies

There are a number of flood damage reduction strategies that can be used by property owners, including many that are low cost. Identification of the source of flooding is fundamental to successfully mitigating future damages. Educating property owners about their flood risk is essential to correctly address property-specific flooding problems. Coordination with the local community officials is often required to identify and confirm the most appropriate flood reduction strategy.

Common Causes and Mitigation Options

A particular structure may experience "flooding" when storm runoff enters a structure as overland flow, infiltration, or sewer backup. Figure 9.1 identifies several of the typical ways water can enter a basement. Table 9.1 lists mitigation measures.

Table 9.1: Summary of basement flood risk reduction options to address damages on site.

Mitigation Options	Cause of Flooding			Damage reduction	Estimated Cost
	Overland	Infiltration	Sewer backup		
Structural Inspection					$250-$800 each
Raise utilities and other valuable items				x	
Insurance				x	Based on coverage
Gutter maintenance	o	x	o		
Downspout disconnection			x		
Site grading, downspout extension	o	x			
Rain gardens	o				$3-40 per square foot
Permeable/porous pavement	x				$2-$10 per square foot
Exterior drain tile		x			$185 per foot
Interior drain tile		x	x		$40-50 per foot
Seal wall and floor cracks		x	o		$300-$600 each
Sump pump with check valve	x	x	x		$400-$1,000 each
Sewer backup valves			x		$3,000-$5,000
Overhead sewer installation			x		$2,000-$10,000
x - primary reduction o - secondary reduction					

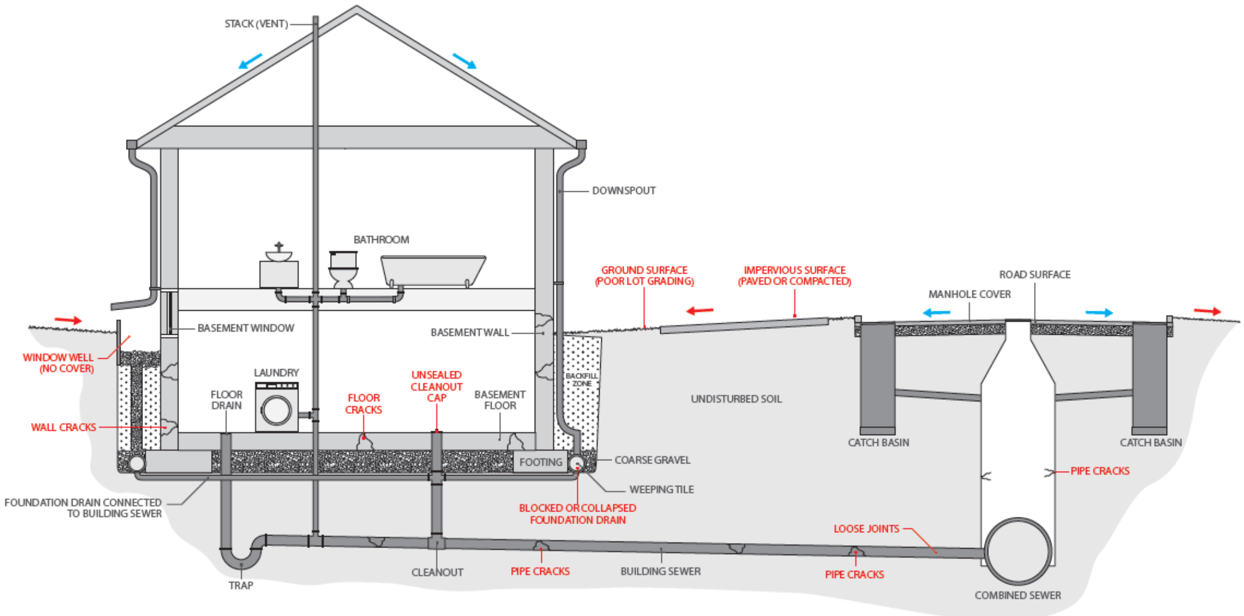


Figure 9.1: Types of urban flooding that can affect a residence. (Credit: Modified from Institute for Catastrophic Loss Reduction, 2009)

Educating Property Owners

Homeowners are often not prepared to evaluate the root cause of flooding and take action to mitigate. While several resources are available online that provide information on identification of problems and appropriate strategies for prevention and maintenance that may assist homeowners in evaluating their flood risk, such as the "Guide to Flood Protection in Northeastern Illinois" (IAFSM, 2006), additional tools and information specific to the local area are needed to reduce flood losses. Education and outreach on identification of root causes is necessary to empower homeowners to solve flooding issues that can only be addressed on their property. Some communities, such as the City of Wheaton, offer drainage reviews for their property owners free of charge, but many communities do not have the resources for such a program. "RainReady Home" (CNT, 2015) is a Center for Neighborhood Technology program that addresses this missing link and, upon completion of the preliminary phase, should be evaluated to document best practices for community response and outreach to urban flooding.

Limitations and Consequences to Reporting Flooding

Evaluation of flood risk should begin at the time of purchase of a property and continue over the ownership of the property. However, flood disclosure laws have gaps, and there is not always a mechanism to disseminate certain historical information. Unlike the Flood Insurance Rate Maps produced by FEMA for riverine flooding, there is not a similar risk evaluation tool for urban flooding issues.

The State of Illinois requires disclosure at sale of the seller's knowledge of material defects to the property. Basement flood disclosure to renters is not explicitly required but is implied in the requirement to disclose any latent basement defect that would make it unfit for occupancy. Illinois' Residential Real Property Disclosure Act provides a comprehensive list of material defects that must be disclosed when property is sold. However, there is hesitancy on the part of property owners to report or disclose flooding issues typically due to a concern that it would lessen the property value. Renters are often uninformed of their risk. There are multiple consequences of not reporting flood issues: new owners do not have the information to mitigate potential flooding and may be caught unaware; renters may experience unexpected losses; communities do not have complete information to develop plans. The issue of communities disclosing full knowledge of historical or studied risk is controversial and has legal repercussions on both sides of the issue.

(765 ILCS 77/35The Residential Real Property Disclosure Act Sec. 35. Disclosure Report Form Excerpts

2. I am aware of flooding or recurring leakage problems in the crawl space or basement.
3. I am aware that the property is located in a flood plain or that I currently have flood hazard insurance on the property.
4. I am aware of material defects in the basement or foundation (including cracks and bulges).
8. I am aware of material defects in the plumbing system (includes such things as water heater, sump pump, water treatment system, sprinkler system, and swimming pool).

Community Level Flood Reduction Strategies

Other causes of urban flood damages must be mitigated at a neighborhood scale with assistance from the community. At this scale, urban flooding is the result of inadequate storm sewer maintenance or overland drainage patterns, and the community is in the best position to implement reduction strategies.

Solving community-level flooding issues can be achieved with some of the same methods, including runoff volume reduction and drainage system maintenance, used for private property but on a larger scale within the context of a comprehensive plan. Successful strategies for communities addressed here are not focused on a specific engineering analysis, which must be determined locally, but rather provide a framework to support local solutions to urban flooding. These strategies include planning, regulation, public-private partnerships and financing. Development of a comprehensive stormwater management plan is a key component in reducing urban flood damage at a neighborhood or community scale, just as it is critical for utilizing green infrastructure and addressing water quality issues (Kramer, 2014; American Rivers et al., 2012). Examples of successful community-based programs at the county level are provided in Chapter 4. These examples demonstrate the success of countywide stormwater authority and programs.

Communities can support sustainable growth economically with municipal regulations that incorporate the stormwater management goal of minimizing runoff volume and thereby reducing urban flooding. Communities should plan for flood routing and prioritize protecting areas of open space with high infiltration and runoff reduction value. The largest communities in Illinois already have stormwater ordinances regulating new development, but many of these could be updated to incorporate more sustainable, low impact development practices and to encourage green infrastructure methods.

Examples of low impact development regulations to address urban flooding issues are listed below.

- Incorporation of green infrastructure practices into stormwater regulations for development
- Maximum parking space requirements rather than minimum parking space requirements; reduce minimum road width to reduce impervious area
- Increase setbacks, increase landscaping requirements, add maximum lot coverage
- Requirement of holding first inch of rainfall
- Encourage re-development rather than new development

Communities should review local regulations to ensure current requirements are not limiting stormwater infiltration and green infrastructure practices. The Center for Watershed Protection published a Code and Ordinance Worksheet to evaluate how supportive a community's regulations are toward sustainable development. The adoption of International building codes (I-codes) assists communities by ensuring structures meet NFIP requirements through the flood provisions incorporated in the code, and providing consistent regulations.

In addition to regulation of new development, there is a need to address stormwater solutions in urban areas that are being redeveloped. Redevelopment can create more urban flooding if an appropriate plan is not in place to use the opportunity to reduce flooding. The Watershed Management Ordinance adopted in Cook County and the DuPage County Stormwater Ordinance requires runoff reduction in redevelopment areas. Additional local regulations can be enacted to address existing plumbing cross connections that direct stormwater into sanitary sewer systems with required inspection prior to closing of a home sale or building permit. However, often regulations do not utilize the opportunity to address urban flooding issues during redevelopment.

In some urban flood areas, public-private partnerships offer an opportunity to address historical flooding areas with solutions on private property. Community cost sharing programs encourage private property owners to implement runoff reduction measures that benefit the property owner and the neighborhood or "sewer-shed." Cost share programs are often used to address limited capacity sewer systems that easily become overwhelmed and back up into basements. These programs have been successful in reducing urban flood damages in communities such as Niles, Northbrook and Wheaton, which offer 50% grant funding to their residents up to $3,000 to $5,000. These programs benefit home owners and are often less expensive for the community than a larger capital improvement project. Program details from the City of Ottawa and the City of Bloomington have been included in Appendix J. The City of Chicago Basement Flooding Partnership (BFP) is a public private partnership that does not require financial contribution from residents and has a large focus on outreach and education.

Flood Routing of Excess Storm Runoff

Flood Route: "A designated strip or piece of land that will receive excess surface runoff not accommodated by storm sewers or other drainage facilities to provide conveyance through developed areas so as to minimize adverse effects of flooding. A flood route shall be provided through the proposed development. The flood route shall be designed for the runoff expected from a 100 year storm frequency in post development conditions or pre development conditions, whichever generates higher flow. Flood Routes shall be located in either public right-of-way, or a dedicated public drainage easement of sufficient width to contain and maintain the channel."
- City of Bloomington flood route requirement for new development

Financing Options

To combat urban flooding and support education and outreach to property owners experiencing flooding, a community must have funding to address local urban flooding issues. While some communities have a dedicated source of funding for stormwater management, many Illinois communities finance stormwater management initiatives out of general revenues at a project level without a consistent source of funding (Appendix B and Appendix C). USEPA recommendations for financing the increasing cost of stormwater management include:

- service fees (often stormwater utilities)
- property taxes/general funds, sales tax,
- special assessment districts,
- system development charges,
- municipal bonds and state grants, and
- low interest loans. (USEPA, 2009).

Table 9.2: Communities with utility fee assessments

Community	Fee Assessment	Year
Aurora	$3.45	1998
Bloomington	$4.35	2004
Champaign	$5.24	2012
Decatur	$3.67	2014
Downers Grove	$8.40	2012
East Moline	$2.61	2009
Freeport	$4.00	
Highland Park	$4.50	
Hoffman Estates	$2.00	2014
Moline	$3.75	2000
Morton	$4.74	2005
Normal	$4.60	2006
Northbrook	$9.00	
Palatine	$5.00	
Rantoul	$3.43	2001
Richton Park	$5.63	
Rock Island	$3.95	2002
Rolling Meadows	$3.36	2001
Tinley Park	$1.68	1983
Urbana	$4.75	2013
Winnetka	$29.67	2014

Consistent funding at an appropriate level enables communities to create stormwater management positions dedicated to comprehensive planning and education and outreach to accomplish urban flood risk reduction.

In recent years, there have been increases in the number of communities enacting stormwater utilities. Illinois still has fewer stormwater utilities than many neighboring Midwestern states (Campbell, 2013). Table 9.2 lists 21 communities with utility fee assessments.

Home-rule and non-home rule communities in Illinois have established stormwater utility programs. Article VIII, Section 6 of the Illinois Constitution established home-rule communities and enables implementation of stormwater fees. Home-rule communities have a more direct path to establishing stormwater utility programs, but non-home rule communities have set up stormwater utilities though they have not yet been challenged. The Illinois Municipal Code allows communities to operate utilities (CMAP, 2013), and townships also have the ability to create a stormwater program and assess a user fee per Public Works Statutes, Article 205 of the Township Code in the Illinois Compiled Statutes

(60 ILCS) (Tri-County Regional Planning Commission, 2013). A Tri-State stormwater utility feasibility study determined that, per 55 ILCS 5/5-1062.3, DuPage and Peoria Counties are able to create stormwater programs and assess fees only if approved by a voter referendum (TCRPC, 2013). The remaining counties in Illinois are currently more limited as the Public Works Statute does not include separate storm sewers.

The USEPA currently provides funds to the State of Illinois for the Clean Water State Revolving Fund, which provides low interest loans for projects that assist with meeting the Clean Water Act goals and better the quality of the watershed (USEPA, 1999). Borrowers include municipalities, communities, businesses, homeowners, and not-for-profit organizations.

While many projects reducing stormwater runoff may already meet the requirements for loans under the Water Pollution Control Loan Program, recent federal legislation expands authority to finance stormwater projects. These new authorities outlined in the Water Resources Reform and Development Act (WRRDA) of 2014 have not yet been adopted by the State of Illinois. Collaboration is required between the Illinois Department of Natural Resources and Illinois Environmental Protection Agency to appropriately expend portions of the state revolving fund for implementation of stormwater management measures.

Water Resources Reform and Development Act of 2014

Title V: Water Infrastructure Financing - Subtitle A: State Water Pollution Control Revolving Funds - (Sec. 5001) Amends the Federal Water Pollution Control Act (commonly known as the Clean Water Act [CWA]) to grant the EPA Administrator general authority to make capitalization grants to states to establish a water pollution control revolving fund to accomplish the objectives, goals, and policies of such Act.

Recommendations

1. The authority to generate revenue from fees, to plan, implement and maintain stormwater management/drainage programs/facilities should be granted to all County Stormwater Planning and Management Agencies (55 ILCS 5/5-1062), counties (55 ILCS 5/Div. 5-15) and municipalities regardless of home rule status.
2. Stormwater Planning and Management authority should be granted to all Illinois counties to adopt countywide stormwater ordinances, projects and programs.
3. The State should provide an annual funding stream for Illinois Department of Natural Resources to buy out both floodplain and urban flood prone repetitive flood loss properties statewide to reduce flood damages and create open space parcels, with deed restriction in perpetuity. The State should provide grants or revolving loan opportunities to communities to support local cost sharing programs for residents impacted by urban flooding for the implementation of mitigation activities.

4. The State should provide grants or revolving loan opportunities to communities to support implementation of local cost sharing mitigation programs for residents impacted by urban flooding, to evaluate stormwater system capacity and flood risk, and to encourage stormwater management planning.

5. Communities should investigate existing property evaluation programs to help homeowners analyze their homes for urban flooding potential and to identify flood damage reduction actions.

6. Communities should consider adoption of ordinances to address drainage for below-grade construction, such as requiring sewers to exit structures within 2 to 3 feet of the finished exterior grade of buildings. Adoption of International Building Code Sections R405 and R406 for foundation drainage and waterproofing should also be considered.

7. The Illinois Department of Natural Resources and Illinois State Water Survey should develop a state model local stormwater ordinance based on concepts in the report which can be used as a template by counties and local communities. The following should be included along with other actions to address urban drainage issues:

    a. Incorporate green infrastructure into municipal and county development regulations by modifying regulations that restrict use of green infrastructure and add regulations to encourage use of green infrastructure in capital improvement projects when possible.
    b. Stormwater infiltration, evapotranspiration and storage should be incorporated into new development and redevelopment wherever possible.
    c. Developers and property owners should be incentivized to dedicate property for increased open space in developing areas, and current open space should be protected to allow for evapotranspiration, infiltration and stormwater storage.
    d. Require a licensed plumber to inspect for sump pump and downspout connections to sanitary sewers when houses are sold.

8. The Illinois Department of Natural Resources and Illinois Environmental Protection Agency should collaborate to appropriately expend portions of the state revolving fund for implementation of stormwater management measures.

9. The State of Illinois should incorporate green infrastructure options in state funded capital improvement projects when practical.

Urban Flooding Awareness Act Report Recommendations

Illinois General Assembly

1. The authority to generate revenue from fees, to plan, implement and maintain stormwater management/drainage programs/facilities should be granted to all County Stormwater Planning and Management Agencies (55 ILCS 5/5-1062), counties (55 ILCS 5/Div. 5-15) and municipalities regardless of home rule status. (Chapters 4 and 9)
2. Stormwater Planning and Management authority should be granted to all Illinois counties to adopt countywide stormwater ordinances, projects and programs. (Chapters 4 and 9)
3. The Illinois General Assembly should allow the Illinois Department of Insurance to mandate continuing education specific to flood insurance for insurance agents. (Chapters 1 and 7)
4. The State should fund the Illinois State Water Survey to update the existing rainfall frequency distribution information using the additional rainfall gauge data that are available with routine updates every 15 years. Future precipitation projections and also future land use should be included where it is available. When planning stormwater infrastructure modifications and enhancements, local governments should take into consideration these future precipitation trends and land use information. (Chapters 2 and 5)
5. Data collection is vital to all flood studies, project design and project operation; therefore, the Illinois General Assembly should continue to provide cost share funding to allow for the following:
    a. maintenance and expansion of the USGS stream and rain gage network by the Illinois Department of Natural Resources;
    b. continued monitoring of climate and flood data by the Illinois State Water Survey to better validate and fine tune the present climate projections and their effects on urban flooding; and
    c. continued monitoring of progress in climate model developments and new scientific approaches to account for climate and other uncertainties. (Chapters 2 and 5)
6. The Illinois General Assembly should fund a state agency to develop an awareness campaign about the risks associated with urban flooding and options available for flood reduction and recovery. An educational flyer should be developed to provide to home buyers at closing. This flyer should provide basic information and resources on flood insurance, sewer backup insurance, flood mitigation, and available programs. Another flyer should be developed to inform renters of insurance coverages available to them. Education and outreach could also include a Flood Awareness week in conjunction with the National Flood Awareness Week. (Chapter 7)

7. The State should provide an annual funding stream for Illinois Department of Natural Resources to buy out both floodplain and urban flood prone repetitive flood loss properties statewide to reduce flood damages and create open space parcels, with deed restriction in perpetuity. (Chapter 9)
8. The Illinois General Assembly should continue (and increase) its funding of flood hazard mitigation programs to allow state agencies to better leverage federal mitigation funds. (Chapter 6)
9. The State should provide grants or revolving loan opportunities to communities to support implementation of local cost sharing mitigation programs for residents impacted by urban flooding, to evaluate stormwater system capacity and flood risk, and to encourage stormwater management planning. (Chapters 6 and 9)
10. Local and county governments should be required to participate in the NFIP as a prerequisite for state funding and grant assistance for flood damage reduction-related activities. (Chapter 6)
11. The State of Illinois should provide funding to the Illinois State Water Survey to study and further develop the topographic wetness indices used for the identification of areas likely prone to urban flooding. This would afford communities the ability to identify areas requiring special consideration for below-ground construction. (Chapter 3)
12. The authorities for justification of state capital projects are currently inconsistent making it more difficult to seek funding from one state agency versus another for similar flood damage reduction purposes. Funding criteria should be made consistent across all state agencies. (Chapter 6)
13. Insurance companies only retain claims data for eight years. The General Assembly should fund a program at the Illinois Department of Insurance to archive basement flood damage claims data from private insurers to maintain a long-term census block database of flooding claims for future analysis. (Chapter 1)
14. The Illinois General Assembly should fund research to determine if lower income households have adequate private basement backup and flood insurance as they appear to have fewer private insurance claims than higher income households. If affordability is an issue with private basement coverage or flood insurance, incentive programs and insurance pools used by other states should be investigated. (Chapter 1 and 7)
15. The Illinois General Assembly should direct research on a state Urban Flood Mitigation Pool funded from a very minimal surcharge on all homeowner's policies in Illinois. This mitigation funding stream could be granted to local governments to identify, study, and mitigate the most egregious urban flood areas in the state. (Chapter 1)

Illinois Congressional Delegation

16. Illinois' congressional delegation should encourage FEMA to allow Community Rating System (CRS) points for state flood damage reduction programs. (Chapter 8)
17. Illinois' congressional delegation should encourage FEMA to consider state-based flood insurance underwriting to more accurately reflect flood loss history in Illinois and establish actuarial premiums within Illinois. (Chapter 7)
18. Illinois' congressional delegation should request that FEMA modify and expand their national CRS training to include Illinois-specific training. (Chapter 8)

Local Government

19. To better utilize funding that is available through Illinois Emergency Management Agency for mitigation projects, communities are encouraged to complete pre-disaster planning. (Chapter 6)
20. Communities should establish overland stormwater conveyance areas in all new development areas, and these flow paths should be maintained and regulated. (Chapter 5)
21. Communities should investigate existing property evaluation programs to help homeowners analyze their homes for urban flooding potential and to identify flood damage reduction actions. (Chapter 9)
22. Communities should improve stormwater management in redeveloping areas by adopting stormwater ordinances that incentivize reduction of imperviousness and updating storm water systems, especially in known flood problem areas. (Chapter 5)
23. Communities should consider real-time monitoring of combined storm sewer systems. When technology allows, they should update the monitoring with a reverse 911 system to alert property owners of imminent flooding. (Chapter 3)
24. Within a reasonable timeframe, communities should update their storm sewer atlas with storm sewer location, infrastructure sizes and design data to allow for evaluation of the effect of changing rainfall patterns on system capacity to more accurately identify areas at risk for urban flooding, and to better inform stormwater management planning. (Chapter 3)
25. Communities should consider adoption of ordinances to address drainage for below-grade construction, such as requiring sewers to exit structures within 2 to 3 feet of the finished exterior grade of buildings. Adoption of International Building Code Sections R405 and R406 for foundation drainage and waterproofing should also be considered. (Chapters 3, 5, and 9)
26. Communities and counties participating in CRS should participate in the Illinois Association of Floodplain Managers (IAFSM) CRS users group. (Chapter 8)
27. Non-CRS municipalities should consider using CRS principles in stormwater management to make their communities more resilient. (Chapter 8)

State Government

28. The Illinois Department of Natural Resources and Illinois State Water Survey should develop a state model local stormwater ordinance based on concepts in the report which can be used as a template by counties and local communities. The following should be included along with other actions to address urban drainage issues:
    d. Incorporate green infrastructure into municipal and county development regulations by modifying regulations that restrict use of green infrastructure and add regulations to encourage use of green infrastructure in capital improvement projects when possible.
    e. Stormwater infiltration, evapotranspiration and storage should be incorporated into new development and redevelopment wherever possible.
    f. Developers and property owners should be incentivized to dedicate property for increased open space in developing areas, and current open space should be protected to allow for evapotranspiration, infiltration and stormwater storage.
    g. Require a licensed plumber to inspect for sump pump and downspout connections to sanitary sewers when houses are sold. (Chapters 4 and 9)
29. The Illinois Department of Natural Resources and Illinois Environmental Protection Agency should collaborate to appropriately expend portions of the state revolving fund for implementation of stormwater management measures. (Chapters 7 and 9)
30. The Illinois Mitigation Advisory Group should expand their mission with representatives from various state agencies to coordinate grant programs and projects to ensure consistent funding requirements, leverage state funding efficiencies, promote resiliency, and avoid project overlap. This group should identify and prioritize urban drainage flood mitigation planning in Illinois so existing mitigation actions can occur quickly and efficiently as funds become available. (Chapter 6)
31. The Illinois Department of Insurance should encourage outreach and education efforts at the local level to ensure that citizens understand the differences between flood insurance and sewer backup coverage. (Chapter 1)
32. The Illinois Department of Natural Resources should expand CRS resources to improve CRS outreach to communities as funding from FEMA is available. (Chapter 8)
33. The State of Illinois should incorporate green infrastructure options in state funded capital improvement projects when practical. (Chapter 9)

Bibliography

Chapter 1

Not applicable

Chapter 2

Changnon, D. M., Sandstrom, M. & Bentley, M. (2007). Midwestern high dew point events 1960-2000. *Physical Geography, 27,* 494-504.

Christensen, J.H., Kjellström, E., Giorgi, F., Lenderink, G. & Rummukainen, M. (2010) *Weight assignment in regional climate models*. Clim Res 44:179-194.

Easterling, W. E., Angel, J. R. & Kirsch, S. A. (1990). The appropriate use of climatic information in Illinois natural-gas utility weather normalization techniques. Illinois State Water Survey, Report of Investigation 112.

Groisman, P. Y., Knight, R. W. & Karl, T. R. (2012). Changes in intense precipitation over the central United States. *Journal of Hydrometeorology, 13,* 47-66.

Intergovernmental Panel on Climate Change (IPCC). (2007). *Climate change 2007*. Synthesis report. A contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press.

IPCC. (2013). The physical Science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. doi: 10.1017/CB09781107415324

Mills, E. (2005). Insurance in a climate of change. *Science* 309(5737):1040-44, doi:10.1126/science. 1112121, LBNL-57943. Retrieved from http://www.sciencemag.org/cgi/content/full/309/5737/1040

Milly, P.C.D., Betancourt, J., Falkenmark, M., Hirsch, R.M., Kundzewicz, Z.W., Lettenmaier, D.P. & Stouffer, R.J. (2008). Stationarity is dead: Whither water management? *Science* 319:573-574.

National Climate Assessment (NCA). Melillo, J. M., Richmond, T.C. & Yohe, G. W. (Eds.). (2014) *Climate change impacts in the United States: The third national climate assessment*. U.S. Global Change Research Program. doi:10.7930/ J0Z31WJ2. http://www.globalchange.gov/

Perica, S., Martin, D., Pavlovic, S. Roy, I., St. Laurent, M. Trypaluk, C. Unruh, D. Yekta, M. Bonnin, G. (2013) *National Oceanic Atmospheric Administration Atlas 14: precipitation-frequency atlas for the United States,* Volume 8 Version 2.0: Midwestern States, U.S. Department of Commerce, NOAA, NWS, Silver Spring, MD.

Smith, L. A., Du, H., Suckling, E. B., & Niehörster, F. (2014). Probabilistic skill in ensemble seasonal forecasts. *Quarterly Journal of the Royal Meteorological Society*. doi:10.1002/qj.2403.

Soong, D. T., Ishii, A. L., Sharpe, J. B. & Avery, C. F. (2004). *Estimating flood-peak discharge magnitudes and frequencies for rural streams in Illinois*. Scientific Investigations Report 2004-5103. U.S. Geological Survey, Reston, Virginia.

U.S. Geological Survey (USGS). (1982*). Guidelines for determining flood flow frequency, Bulletin 17B*. Reston, Virginia.

Chapter 3

Chapman, J. B. & Canaan, W.D. (2001). Flood maps are key to better flood damage control. *CE News*, 58-60.

Chicago Metropolitan Agency for Planning (CMAP). (2008). *Stormwater management strategy paper*. Retrieved from http://www.cmap.illinois.gov/documents/10180/61694/Stormwater+ Management.pdf/ 608fda0 0-30b0-43ea-b7a6-083e134b91c2

Federal Aviation Administration. (2015). *Small UAS Notice of Proposed Rulemaking (NPRM).* Retrieved from https://www.faa.gov/uas/nprm/

Federal Emergency Management Agency. (2015). *National Flood Hazard Layer(NFHL)*. Retrieved from http://msc.fema.gov/portal

Jin, S., Yang, L., Danielson, P., Homer, C., Fry, J., & Xian, G. (2013). A comprehensive change detection method for updating the National Land Cover Database to circa 2011. *Remote Sensing of Environment*, 132: 159 – 175. Available online http://www.mrlc.gov/faq_dau.php.

National Oceanic and Atmospheric Administration (NOAA), National Weather Service. Advanced hydrologic prediction service. Retrieved from http://water.weather.gov/precip/download.php

Pathak, P.A. (2010).*Geospatial analysis of lake and landscape Interactions within the Toolik Lake region, North Slope of Alaska.*

Quist, G., Drake, D., & Hobbs, J. (n.d.). Knowledge is power - using remote monitoring to optimize operations. *Proceedings of the Water Environment Federation, Collection Systems 2010*, *12,* 571-582.

Rawls, W.J., Brakensiek, D.L. & Soni, B. (1983). Agricultural management effects on soil water processes, Part I. Soil water retention and green and ampt infiltration parameters. *Transactions of the American Society of Agricultural and Biological Engineers 26(6),* 1747-1752.

United States Department of Agriculture. Natural Resources Conservation Service. *Web soil survey*. Retrieved form http://websoilsurvey.nrcs.usda.gov/

U.S. Census Bureau. (2014). *2014 TIGER/Line Shapefiles*. Retrieved from http://www.census.gov/geo/ maps- data/ data/tiger-line.html

Wolock, D.M., (1993). Simulating the variable-source-area concept of streamflow generation with the watershed model TOPMODEL. USGS Water-resource investigation report 93-4124, Lawrence, KS.

Chapter 4

Not applicable

Chapter 5

Association of State Floodplain Managers (ASFPM). (2004). *Reducing flood losses is the 1% chance flood standard sufficient?*. Report of the 2004 Assembly of the Gilbert F. White Flood Policy Forum, Washington, DC.

Bonnin, G. M., Martin, D., Lin, B., Parzybok, T., Yekta, M., & Riley, D. (2006). *National Oceanic Atmospheric Administration Atlas 14: precipitation frequency atlas for the United States, Volume 2 Version 3.0:* Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia. U.S. Department of Commerce. Silver Spring, MD.

Chicago Metropolitan Agency for Planning (CMAP). (1990). *Model stormwater drainage and detention ordinance*. Chicago, IL. Retrieved from http://www.cmap.illinois.gov/documents/10180/12532/Stormwater+Drainage+and+Detention+Ordinance.pdf/c2199225-64e6-40d1-8056-3ebe8e66c501

CMAP. (1994). *Addendum to model stormwater drainage and detention ordinance. Chicago, IL*. Retrieved from http://www.cmap.illinois.gov/documents/10180/12532/Stormwater+Drainage+and+ Detention+Ordinance.pdf/c2199225-64e6-40d1-8056-3ebe8e66c501

CMAP. (2008). *Stormwater management strategy paper*. Chicago, IL. Retrieved from http://www.cmap.illinois.gov/documents/10180/61694/Stormwater+Management.pdf/608fda00-30b0-43ea-b7a6-083e134b91c2

Chow, V. T., Maidment, D. R., & Mays, L. W. (1988). *Applied hydrology*. New York, NY: McGraw-Hill.

Dreher, D., Hey, D., & Schaefer, G. (1989). *Evaluation of stormwater detention effectiveness in Northeastern Illinois*. Chicago, IL: CMAP.

Dreher, D. & Price, T. (1991). *Investigation of hydrologic design methods for urban development in Northeastern Illinois*. Chicago, IL: CMAP.

Federal Interagency Stream Restoration Working Group (FISRWG). (2001). *Stream corridor restoration: principles, processes, and practices*. Part 653 of the National Engineering Handbook, U.S. Department of Agriculture, Natural Resources Conservation Service.

Hershfield, D.M. (1961). *Rainfall frequency atlas of the United States for durations from 30 min to 24 h and return periods from 1 to 100 years. Technical Paper No. 40*. Weather Bureau, U.S. Department of Commerce, Washington, DC.

Huff, F. A. & Angel, J. R. (1989). *Rainfall distributions and hydroclimatic characteristics of heavy rainstorms in Illinois (Bulletin 70)*. Champaign, IL: Illinois State Water Survey.

Illinois Department of Transportation (IDOT). (2011). *Drainage manual*. Springfield, IL: Bureau of Bridges and Structures.

Karkowski, R., Ahern, D., & Klink, R. (2014). *Volume based hydrology design it is time?* Beaufort County South Carolina, Department of Engineering and Infrastructure. Retrieved from http://www.bcgov.net/ departments/ Engineering-and-Infrastructure/stormwater-management/documents/WQ-Monitoring-page/volume-based-hydrology-design-is-it-time.pdf

Mays, L. W. (2005). *Water resources engineering* (2005 ed.). Hoboken, NJ: John Wiley and Sons.

Maki, B. (2007a). *WMO regulatory requirement recommendations, stormwater drainage and detention* [Memorandum]. Chicago, IL: Engineering Resources Associates, Inc.

Maki, B. (2007b). *WMO regulatory requirement recommendations, detention release rate and required storage* [Memorandum]. Chicago, IL: Engineering Resources Associates, Inc.

Southwestern Illinois Planning Commission (SIPC). (1997). *A model ordinance providing for the control of stormwater drainage and detention, soil erosion and sediment control*. Illinois Environmental Protection Agency, Contract No. 97-604-2.

U.S. Environmental Protection Agency (USEPA), (2009). *Technical guidance on implementing the stormwater runoff requirements for federal projects under Section 438 of the Energy Independence and Security Act,* EPA 841-B-09-001.

Westcott, N. (2015). *Continued operation of a 25-raingage network for collection, reduction, and analysis of precipitation data for Lake Michigan diversion accounting: water year 2014,* Illinois State Water Survey Contract Report 2015-01, Illinois State Water Survey, Prairie Research Institute, University of Illinois, Champaign, IL, 86 p.

Chapter 6

Not applicable

Chapter 7

Association of State Floodplain Managers (ASFPM). (2013). *Flood insurance affordability-update. ASFPM recommendations to address the impact of NFIP Reform 2012* (BW-12) [Issue Paper]. Retrieved from www.floods.org/ace-files/documentlibrary/2012_NFIP_Reform/Flood_Insurance_ Affordability_version_10222013.pdf

Center for Neighborhood Technology (CNT). (2014). *The prevalence and cost of urban flooding. A case study of Cook County, IL*. Retrieved from www.cnt.org/sites/default/files/publications/CNT_ PrevalenceAndCostOfUrbanFlooding20141.pdf

Czajkowski, J., Kunreuther, H., & Michel-Kerjan, E. O. (2012, January). *A methodological approach for pricing flood insurance and evaluating loss reduction measures: Application to Texas*. Retrieved from http://opim.wharton.upenn.edu/risk/library/WhartonRiskCenter_TexasFloodInsurance PricingStudy_ExecSummary.pdf

Czajkowski, J., Kunreuther, H., Michel-Kerjan, E. O. (2013). *Analysis of flood insurance protection: The case of the Rockaway Peninsula in New York City* [Issue Brief]. Retrieved from http://opim.wharton.upenn.edu/risk/library/WRCib2013c_Flood-Ins-RockawaysNYC.pdf

The Current. (2015, January-February). *Flood or water back-Up? Determining coverage for "flooded" basements.*

Dixon, L., Clancy, N. Bender, B., Kofner, A. Manheim, D. Zakaras, L. (2013). *Flood insurance in New York City following Hurricane Sandy*. Santa Monica, CA: RAND Corporation. Retrieved from www.RAND.org

Insurance Information Institute. (2009, April). *Yuck. Are you insured for sewer backup?* [Press Release]. Retrieved from http://www.iii.org/press-release/yuckare-you-insured-for-sewer-backup-040809

Insurance Information Institute. (2013, July). *Sewer backup*. Retrieved from www.iii.org/article/sewer-backup

Kousky, C. & Kunreuther, H. (2014). Addressing affordability in the National Flood Insurance Program. *Journal of Extreme Events*, Vol. 01, No. 01. Retrieved from http://opim.wharton.upenn.edu/ risk/library/ J2014_JEE_Addressing-Affordability-NFIP.pdf

McCormick, R. (2001, July). Sump pump failure and water back-up: HO policy concerns. Retrieved from www.roughnotes.com/rnmagazine/2001/july01/07p116.htm

Mathewson, C., Causgrove, P., Krutov, A., Frankowiak, S. (2011, July). *The National Flood Insurance Program: Past, present…and future?* [Public Policy Monograph]. American Academy of Actuaries Flood Insurance Subcommittee. www.actuary.org/files/publications/AcademyFlood Insurance_ Monograph_110715.pdf

RAND Corporation. (2006). *Evaluating national flood insurance* [Research Brief]. Retrieved from www.RAND.org/pubs/research_briefs/RB9176/index1.html

RAND Corporation. (2007). *Private insurers play a limited, but key, role in underwriting residential flood insurance* [Fact Sheet]. Retrieved from www.RAND.org/pubs/research_briefs/RB9270 /index1.html

RAND Corporation. (2013, October 25). *Rising cost of flood insurance will create serious challenges for New York City* [Press Release]. Retrieved from www.RAND.org/news/press/2013/10/25.html

Zakaras, L. (2010). *Call for reform in the residential insurance market after Hurricane Katrina* [Research Brief]. RAND Corporation. Retrieved from www.RAND.org/pubs/research_briefs/RB9558/ index1.html

Zhao, W. (2014). *Affordability of the National Flood Insurance Program: A case study of Charleston County, South Carolina*. Retrieved from http://repository.upenn.edu/wharton_ research_scholars/114

Zolkos, R. (2013, October) *New York faces a series of flood-related risks: Analysis*. Business Insurance. Retrieved from www.businessinsurance.com/article/20131025/NEWS06/131029849

Chapter 8

Federal Emergency Management Agency (FEMA). (2013). *CRS coordinator's manual*.

FEMA. (2015, April 13). *National flood insurance program community rating system.* Retrieved from https://www.fema.gov/national-flood-insurance-program-community-rating-system

FEMA. (2015, April 23). *Floodplain management*. Retrieved from https://www.fema.gov/floodplain-management/

Chapter 9

American Rivers, Center for Neighborhood Technology, & The Great Lakes and St. Lawrence Cities Initiative. (2012). *Upgrade your infrastructure, a guide to the green infrastructure portfolio standard and building stormwater retrofits.* Retrieved from http://www.cnt.org/media/CNT_UpgradeYourInfrastructure.pdf

Campbell, W. (2013). *Western Kentucky University stormwater utility survey 2013*. Bowling Green, KY: Western Kentucky University.

Center for Neighborhood Technology (CNT). (2015). *A rainready nation, protecting American homes and businesses in a changing climate.* Chicago, IL. Retrieved from http://www.cnt.org/resources/a-rainready-nation-protecting-american-homes-and-businesses-in-a-changing-climate/

Chicago Metropolitan Agency for Planning. (2013). *The value of stormwater utilities for local governments in the Chicago region.* Chicago, IL. Retrieved from http://www.cmap.illinois.gov/documents/10180/11674/stormwater_utilities_for_local_govts.pdf/866a64a4-ef11-47ce-b4ec-2293686d4a70

Copeland, C. (2014). *Green Infrastructure and Issues in Managing Urban Stormwater.* Washington, DC : Congressional Research Service.

Illinois Association for Floodplain and Stormwater Management (IAFSM). (2006). *Guide to flood protection in northeastern Illinois.* Retrieved from http://www.illinoisfloods.org/documents/Guide_to_Flood_Prot--March_06.pdf

Kramer, M. (2014). *Enhancing sustainable communities with green infrastructure. A guide to help communities better manage stormwater while achieving other environmental public health, social and economic benefits.* Washington, DC: United States Environmental Protection Agency. EPA 100-R-14-006

Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. (2007). *Urban subwatershed restoration manual no. 3. Urban stormwater retrofit practice, Version 1.0.* Ellicott City, MD: Center for Watershed Protection.

Tri-county Regional Planning Commission (TCRPC). (2014). *Stormwater utility feasibility study*. Peoria, IL.

United States Environmental Protection Agency (USEPA). (1999). *The clean water state revolving fund program.* Washington, DC: EPA 832-F-99-051.

USEPA. (2009). *Funding stormwater programs*. Springfield, IL: EPA 901-F-004.

Appendices

The following appendices are located on the accompanying disc.

Appendix A: Urban Areas and Urban Demographics

Appendix B: Stakeholder Engagement and Data Gathering

Appendix C: Illinois Flood Risk Symposium Report

Appendix D: Prevalence and Cost

Appendix E: Climate Trends and Climate Change

Appendix F: Technology and Data for Identification of Urban Flooding Potential

Appendix G: County Stormwater Program Impacts on Urban Flooding

Appendix H: Stormwater Design Standards

Appendix I: National Flood Insurance Program (NFIP) and Community Rating System

Appendix J: Strategies to Minimize Damages from Urban Flooding